THE GLASS INDUSTRY

VOLUME 32, NUMBER 6, JUNE, 1951

DEFENSE MOBILIZATION IS KEYNOTE AT G.C.M.I. MEETING

The Semi-Annual Meeting of the Glass Container Manufacturers Institute was called to order on Monday, May 21, in The Greenbrier, White Sulphur Springs, West Va., by Lewis F. Gayner, Executive Vice President of Gayner Glass Works.

Mr. Gayner, who has so ably filled the post of President of the Institute for the maximum term of two years, is succeeded by Joseph C. Feagley, Vice President and General Manager of the Glass Container Division of Armstrong Cork Company. Howard C. Herger, President of Pierce Glass Company, was elected 1st Vice President and Phillip O'C. White, Secretary of White Cap Company, was elected 2nd Vice President.

Four concerns were announced as new members of the Institute; namely, Owens-Illinois Glass Company, Ball Brothers Company, Thatcher Glass Manufacturing Company, and Lynch Corporation. Among the four new members, Ball Brothers, Thatcher, and Owens-Illinois have contributed to the G.C.M.I. and through their technically skilled employees have cooperated with the Institute's nine standing committees.

Because the Defense Mobilization Program dominates the entire American business scene and is increasing the demand for packaged products, the entire Monday session was devoted to the defense program and its impact on the glass container industry. As a result of the effect of defense planning on usual business procedures, five representatives of the defense agencies were invited to deal with their respective phases of the mobilization program of greatest interest to the glass container and allied industries.

Horace B. McCoy, Assistant Administrator of the National Production Authority, in his talk, "The Scope and Character of Controls in a Defense Economy", presented some interesting views on the objectives of certain controls and gave the attending glassmen an outline of the present and near-future situations of supply of certain basic materials of primary interest to the glass container industry.

J. C. Feagley

Gabriel J. Ticoulat, Director of the Pulp, Paper and Paper Board Division of N.P.A. and now on leave from Crown Zellerbach Corporation, delivered a talk on "Pulp and Paper in the Defense Program".

If there was any question as to the importance which glassmen placed on paper as a commodity of the utmost essentiality—which there was not—any doubt would have been quickly dispelled by Mr. Ticoulat's talk. His discussion, although succinctly presented, covered the many problems involved in providing paper for the needs of industry and present day civilization. It is hoped that Mr. Ticoulat's talk can be printed in full in a subsequent issue of THE GLASS INDUSTRY.

The "Role of Containers in a Defense Economy" was the title of a talk delivered by Charles E. Lewis, Acting Director of the Containers and Packaging Division of N.P.A. As the title of the paper implies, Mr. Lewis' discussion was not limited to glass alone, but covered all types of containers and the problems of supply materials necessary to their production.

Highlighting the General Session devoted to the Defense Mobilization Program was the talk delivered by the genial Director of the Office of Price Stabilization, Michael V. DiSalle. In his discussion, which was labeled "Price Stabilization and the Defense Program", Mr. DiSalle broadly covered the ramifications of the O.P.S. and some of the problems encountered at various levels.

Concluding the session, Herman B. Esselen, Acting Chief of the Glass Container and Closure Section of N.P.A., delivered an address to the glassmen, which was to some extent historical since it broadly chronicled the activities of his section since its formation. He touched on tin allocations for tin plate for closures, the aluminum order M7, pointing out the present controls on aluminum for closures as compared with those in effect in World War II, and he then explained the

H. C. Herger

purposes of the glass container standardization order. This order was designed to increase the supply of glass containers for packaging by doing three things: (1) to prohibit the creation of new designs, (2) to establish certain designs of wide usefulness, simplified designs which any container manufacturer might produce and any packer might use, and (3) require that specified products be packaged only in designated containers of simplified design. This third phase has not yet been put into operation.

Mr. Esselen pointed out that of the three steps in the order, the first two are preparatory and outlined the philosophy behind these three steps, as follows: "In issuing this order, it was recognized that certain hardships were involved. Glass container manufacturers were prohibited from creating and exploiting new designs, one of the great advantages which they possess in the packaging field is that glass containers can be made in an almost unlimited variety of useful and attractive designs. Packers were likewise prohibited from developing and using new designs of glass containers as a means of making their packages more attractive. It was felt, however, that this diversion from creation of new designs to the use of designs in existence would not constitute an undue hardship since there are literally thousands of designs in existence and all that packers are being asked to do is to get along with the designs they have been using. In particular, this seemed to be a relatively limited hardship as contrasted with the alternative of giving preference in the distribution of glass containers to packagers of products of greater essentiality.

"You are all familiar with step two. The simplified designs have been published in Schedule 1 of the order. Anyone may produce and anyone may use them.

"With steps one and two behind us, our preparatory work is done. Step three involves the requirement that specified products be packaged only in designated containers of simplified design. This step is the heart of the order since when and if it is taken we gain in production the benefits in volume, both in units and capacity, which result from longer runs of good production items.

"We are ready to proceed with step three when the appropriate time for that step arrives. In determining when that time has arrived, we will be guided by the supply and demand situation in the industry. So far we have not had to deal with situations where either individual concerns or whole industries have experienced unusual difficulties in obtaining glass containers."

In closing, Mr. Esselen paid tribute to the industry consultants to N.P.A.—Harold J. Carr, Owens-Illinois Glass Company, on glass problems, and Stanley Dennis, Crown Cork & Seal Company, on closure matters—for their cooperation and helpfulness to the Glass and Closure Section.

A question and answer period was held following the last speaker during which many interesting points were brought out for further discussion with all members of the Defense Mobilization Program panel participating.

On Tuesday morning the business session was called to order at 9:30, at which time the membership received the reports of President Lewis F. Gayner, General Counsel Fred E. Fuller, General Manager Victor L. Hall, West Coast Manager R. L. Cheney, and Secretary H. W. Kuni.

The report of the Nominating Committee was received and after various business matters were disposed of, the membership received the reports of the Nine Standing Committees of the Institute. These written reports were supplemented orally by S. B. DeMerrell, Anchor Hocking Glass Corporation, heading the Committee on Government-Industry Relations, E. G. Siedle, Armstrong Cork Company, Chairman of the Traffic Committee, and Ralph Lind, Secretary of the Labor Committee, who commented on the report of the Committee on Labor Relations which is headed by L. C. Roche of Maryland Glass Corporation.

Market Research

Francis H. May, Chairman of the Market Research and Promotion Committee, submitted in substance the final report of this group. He reported that with the advent of the Korea conflict and the Defense Mobilization Program it was felt that if any promotional effort be made at all it should be institutional rather than specifically aimed at segments of glass container markets.

P. O'C. White

However, it soon became apparent that the national and international scene would completely change the picture from a standpoint of the industry's requirements. It was therefore felt that a continuation of any kind of promotional effort would be unwise and the Trustees of the Institute sensing the impending demands on the industry deemed it wiser to forego any further promotional effort, which decision was concurred in fully by the Marketing Committee.

Traffic

E. J. Siedle, Armstrong Cork Company and new Chairman of the Traffic Committee, prefaced his report to the Trustees with a tribute to his predecessor, the late Irvine L. Dunnington, and proposed an appropriate resolution that the Committee's sympathy be extended to Mr. Dunnington's family. This resolution was further acted upon by the entire membership.

In reporting on the matter of reduced freight rates for glass containers in the Eastern Territory, Mr. Siedle stated that while there had been a substantial increase in the number of cars and tons of glass containers handled by railroads, there also had been a larger volume handled by motor trucks. Nevertheless, as a result of negotiations entered into by the Institute, the railroads had agreed to extend applications of the readjusted rates for another year—to expire on April 20, 1952.

These rates, which were originally agreed upon by the railroads, were intended to help the rail carriers meet

the competition of the trucking industry. It is hoped by the Committee that since these rates have proved beneficial to the railroads, a plan of procedure may be evolved that will bring about the establishment of these rates on a permanent basis.

The Traffic Committee further reported on several other matters including reduced freight rates on soda ash between points in Eastern Territory and freight rates on sand in the same area. The petition of the railroad for a further increase in freight rates has been studied and the position of the motor carriers rates and equipment has also had the careful attention of the Traffic Committee.

Government-Industry Relations

S. B. DeMerrell, Anchor Hocking Glass Corporation, as Chairman of the Committee on Government-Industry Relations, introduced his report with a review of the defense agencies' activities from their inception to date. He pointed out the importance of the establishment of a Washington office of the G.C.M.I. where Harry W. Kuni is spending a major portion of his time in behalf of the entire glass container and closure industry.

The Office of Price Stabilization is in the process of forming a glass container manufacturers advisory committee. It was further pointed out that both the N.P.A. and O.P.S. frequently call upon the Glass Container Manufacturers Institute for assistance in view of its extensive knowledge of glass container and closure manufacture, as well as its understanding of the packaging field in general.

The work of the West Coast sub-committee, under the guidance of R. L. Cheney, was reviewed by Mr. DeMerrell with special emphasis on Mr. Cheney's activities in connection with the Fuel and Power Committee of the California Manufacturers Association. This work is said to have provided important savings to West Coast glass container manufacturers, as well as to those in other industries, with important savings in fuel bills. It was further stated that important work has been accomplished in connection with the regulation of the Los Angeles Smog Control Authority.

Testing Procedures

John H. Steuernagle, Brockway Glass Company, as Chairman of the Committee on Testing Procedures, detailed the work of Dr. Ghering, of Preston Laboratories, and his group on such technical matters as internal abrasions, impact and light-weighting, and testing procedures and apparatus.

Future plans of the Committee for the next twelve months include a continuance of the study of light-weighting and an extension of the work to include a more detailed study of the distribution of the glass in the individual container.

Glass Packed Products

In reviewing the work of the Technical Committee on Glass Packed Products, Chairman John M. Sharf, of Armstrong Cork Company, stated that the Committee's membership had been increased since the last meeting of the group. He also briefly summarized the activities of the West Coast Special Committee and pointed out the very helpful cooperation of representatives of the National Canners Association, the Hooper Foundation, and particularly the Fellowship Group of the University of Massachusetts, which the Committee at large has enjoyed.

The work on baby foods at the University of Massachusetts is being expanded. Other studies, such as the pasteurization of fresh cucumber pickles, thermal destruction of enzymes, control of spoilage of micro-organisms in acid foods, and the stability of fruit pigments were briefly reviewed.

Standards for Finishes

C. C. Green, of Armstrong Cork Company and Chairman of the Committee on Standards for Finishes, stated that this Committee has given consideration to a number

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Golfers pausing for the photographer at White Sulphur Springs, left to right, Howard C. Herger, Michael V. DiSalle, Fred E. Fuller, and Lewis F. Gayner.

THE BASIC PROBLEM OF THE STRENGTH OF GLASS

By F. W. PRESTON

Preston Laboratories, Butler, Pa.

Lewis Carroll, who wrote *Alice in Wonderland*, elaborated on part of it in a poem entitled, "The Hunting of the Snark, an Agony in Eight Fits."[1] Many of you no doubt know it. "Fit the First" begins:

"Just the place for a Snark! the Bellman cried,
As he landed his crew with care,
Supporting each man on the top of the tide
With a finger entwined in his hair.

"Just the place for a Snark! I have said it twice—
That alone should encourage the crew:
Just the place for a Snark! I have said it thrice—
What I tell you three times is true."

When, six months ago, I acceded to your Chairman's request that I speak to your group today, he sent me a pamphlet put out by your Society, entitled "Guide to Speakers". This gravely assured me that it is not the custom of Chemical Engineers to believe anything unless it is repeated three times.[2] I was instructed to tell you what I was going to say, and then to tell you— that alone should encourage the crew—and finally to tell you what I had told you—what I told you three times would be true. The same document contained many dark hints as to what would happen to me if I did not act in every detail according to a most rigid specification. The slightest lapse into originality, and the least I could expect would be, to be lynched.

When I heard that the other three speakers would be provided by Pittsburgh Plate Glass Company, one of our finest and most progressive manufacturers, Battelle Memorial Institute, and Corning Glass Works, I could see that the only excuse for dragging me in would be to provide a little comic relief, such as a lynching party. I could see that the others, with their great research organizations and vast experience behind them, would give you all the facts and figures, all the data on manufacturing and end uses, that were anywhere available. All that would be left to me would be the fiction and the speculation. Let us therefore resign ourselves to the assignment and do a little speculating as to what happens when a piece of glass breaks.

However, since this discussion must be conducted in the spirit of a snark-hunt, we must first get Lewis Carroll's instructions as to how to proceed.[3]

"You seek it with thimbles, you seek it with care,
Pursue it with forks and hope:
You threaten its life with a railway share
And charm it with smiles and soap."

Translated into the vernacular of the atomic age, I construe this to mean that when dealing with something as elusive as a snark or the fracturing of glass, you should use every conceivable approach. We shall, therefore, gallop rapidly in all directions.

However, a word of warning is necessary.

"For although common Snarks do no manner of harm,
Yet I feel it my duty to say,
Some are Boojums. . . ."

and

"Oh, beamish nephew, beware of the day
If your Snark be a Boojum! For then
You will softly and silently vanish away
And never be met with again!"[4]

And now having described the method of procedure and the dangers involved, we may begin our investigations.

Perhaps some of you, now turned respectable, were present in the Malamute Saloon up in the Klondike that night when a bunch of us boys was a-whooping it up, and Lou's husband and Dan McGrew shot it out in the dark. Bob Service[5] did not record it, but perhaps you remember how some of the bullets went wild, and smack through the window, which unfortunately was not made by Pittsburgh Plate, *one of our finest and most progressive manufacturers.* There was a small hole, big enough to let the bullet through, and more or less circular, though ragged, and radiating from the hole to the edges of the glass were a number of cracks. These cracks traveled at a great speed, far too fast for the eye to follow. Their speed was not the velocity of sound, i.e. of longitudinal vibrations in glass, which is three miles a second, nor is it the velocity of transverse vibrations, which is two miles a second. It is a new physical constant of glass, the limiting velocity of crack propagation, and is one mile per second.

Now, unless you can account for this velocity in terms of physics, chemistry, or chemical engineering, and prophesy its value from other physical constants of the material, you do not know what happens when glass breaks. This then is our central problem, expressed perhaps in its simplest form.

Now, I am about to tell you that there is an element of mystery in the phenomena of breakage: for the next fifteen minutes or so I shall be telling you in what way it is mysterious: and at the end, if I don't forget, I will remind you that what I have been saying is that we don't really understand what happens when glass breaks. What I tell you three times will be true.

That is all there is to it. The rest is mere detail, and you do not need to pay any attention unless you like.

We seek an explanation with the aid of a thimble provided by Nelson Taylor. I have given elsewhere[6] his argument-from-analogy exactly as he gave it to me. I give it here in a slightly elaborated form, in deference to the distinguished audience.[7] It goes

$$v_p = \sqrt{E/\rho} \quad \text{or} \quad E = \rho v_p^2$$
$$v_s = \sqrt{G/\rho} \quad \text{or} \quad G = \rho v_s^2$$
$$v_c = \sqrt{f/\rho} \quad \text{or} \quad f = \rho v_c^2$$

Here ρ is density, E is Young's Modulus, and v_p is the velocity of pressure waves in the glass, that is, the ve-

A condensed version of a lecture given to the American Institute of Chemical Engineers, at Columbus, Ohio, December 5, 1950.

locity of sound. G is the Shear or Torsion Modulus, and v_s is the velocity of shear waves or transverse waves. Jeffreys[8] quotes Turner as calling the v_p wave the "push" wave, and v_s the "shake" wave. v_c is the velocity of crack propagation, and f is some "modulus" or other, having like E and G, the physical dimensions of a stress, and bearing the same degree of relevancy to cracking as E does to sound propagation.

Since cracking is a response to tensile stress, the logical interpretation is that f is the limiting tensile stress the glass can stand, presumably the instantaneous value of the stress at the tip of the crack.

Now there is no great difficulty in measuring ρ, the density. Anyone with six or eight years of college physics ought to be able to do it. The measuring of v_c, the cracking velocity, is less simple but entirely practicable with modern electronic equipment, so that f can be calculated to about 1% with fair accuracy. All that remains is to measure the tensile strength of glass and see if the value so obtained agrees with f as calculated.

But this is where we run into trouble. The value of f as calculated for Pittsburgh Plate glass is about 840,000 lb./sq. in., but Pittsburgh Plate will not sell it as being good for that figure. They probably won't warrant it for 8,400, or one per cent of that value, in spite of their being one of our—but never mind. Several people, including our laboratories, have measured the cracking velocity, and we feel confident of its value to approximately 1%. This, I sometimes think, is something of a feat, when we measure a velocity of 5000 ft/sec. by timing it over a distance of one inch. We have demonstrated, too, that the velocity of cracking is only very slightly affected by variations of temperature. We have found, for instance, that with glass like Pittsburgh Plate's, which "ought" to stand about 840,000 lb./sq. in., we can in fact reach approximately 630,000. And with fused silica, whose computed strength is 1,550,000 lb./sq. in., we can frequently reach 800,000 and on occasion, 1,270,000. At present we feel that Nelson Taylor may have hit on a formula that under normal conditions is sound.

However, you are probably going to reply that even if it is sound, it has not advanced our understanding very much because it has not connected up strength, or cracking velocity, with fundamental atomic or molecular constants. Nelson Taylor's formula does not touch on molecular structure. It merely connects together three molar quantities, like a jawbone.

If we take Hooke's Law $\epsilon = f/E$, where ϵ is strain, and combine it with Nelson Taylor's formula $f = \rho v_c^2$, and with the formula for the velocity of sound in a thin rod or fiber, $v_p = \sqrt{E/\rho}$, we may deduce that $\epsilon = (v_c/v_p)^2$, ϵ being now the limiting theoretical strain.

This formula has an engaging simplicity. We do not have to measure stress at all, a thing that normally involves measuring a force and a cross-sectional area, the latter often very difficult on almost microscopic fibers, for instance. We do not have to measure Young's Modulus, or even density. We do not have to measure even cracking velocity, but only the ratio of cracking velocity to sound velocity, and this can be done, without measuring either velocity separately, by Edgerton's method which gives v_c/v_s immediately, and v_p may be deducted if we know Poisson's Ratio. However, the formula still runs into the difficulty that the limiting strain ϵ is not easily observable due to imperfections of all natural specimens.

Let us turn, then, to another approach that has been suggested. On the basis of C. E. Inglis' theory of cracks, there is an approximate equality to be expected of the form

$$f \sim \sqrt{E\sigma/r} \qquad (4)$$

Your Society's "Guide to Speakers" calls for slides that are not over-crowded with information. I heartily concur. This is my idea of an almost ideal slide. It has next to nothing on it. Just four symbols, and each symbol good for a terrific headache.

Your Society, in its booklet, commends slides of this character. But Lewis Carroll went them one better, for the Bellman

". . . had bought a large map representing the sea
Without the least vestige of land:
And the crew were much pleased when they found it to be
A map they could all understand.
'Other maps are such shapes with their islands and capes!
But we've our brave Captain to thank
(So the crew would protest) that he's bought us the best—
A perfect and absolute blank.' "

Now you may think this slide is not a perfect and absolute blank because it has a few symbols on it. But wait till I get through. It is blanker than you think.

In the formula, f is the limiting tensile stress, and E is Young's Modulus, as before. σ is the surface energy of the newly fractured surface, and r is the "effective" radius at the head of the crack, which, in the case of such brittle substances as fused silica and Pittsburgh Plate glass, is presumably approximately equal to the atomic spacing. Here, therefore, we have a formula that shows some promise of getting down to molecular properties.

As compared with Nelson Taylor's formula, it has, however, some disadvantages, one of which is that all of the ingredients are impossible to measure with any accuracy. I have already explained that f is very difficult to measure experimentally. E ought to be easy, and *is* easy as a statistical average over a large specimen at low stresses. But we are here dealing with a phenomenon at, or near, the molecular level, in a tiny volume and at very high stresses. I think it would be rash to assume that E is then within even a few per cent of its molar value.

The other two quantities are much worse. The surface energy in ergs/cm.^{2} is usually assumed to be numerically equal to the surface tension in dynes/cm., though this has latterly been disputed for at least some cases. At elevated temperatures when the glass is soft, the surface tension has been measured by many experimenters and by many methods with disconcertingly diverse results. I shall merely say that at room temperature values of surface energy have been deduced or measured that range all the way from 200 ergs/cm.^{2} up to over 100,000.

Evidently it involves a considerable mental hazard to assume any value whatever for the surface energy, or surface tension, of our silicates at room temperature, and it involves a corresponding risk to any conclusions we

may draw from a formula involving surface energy as one of its elements.

A rather lengthy discussion of surface energy would be warranted by the fact that many of the formulae, and not only Inglis', purporting to estimate the theoretical strength, do require a knowledge of the surface tension. Nelson Taylor's formula is almost alone in avoiding this.

We now leave the Taylor and Inglis thimbles alone and try pursuing with forks and hope.

To a chemist, and in particular to a chemical engineer, I imagine the logical approach to this subject of strength would be to equate the strain energy, introduced by stretching a fiber, to the bonding energy of the atoms, or rather to that part of the bonding energy that can be visualized as operative in opposition to the stress. The bonding energy ought to be calculable from the heat of combustion, e.g. the burning of elemental silicon in oxygen. However, even this is subject to some uncertainty, because what is being held together is not O = Si = O, but a high polymer of it, in which the bonds are not strained and distorted to such a fantastic extent. Perhaps what we are concerned with is not the heat of combustion at the molecular level, but the heat of polymerization.

The mechanical strain energy is easier to define. It is $f^2/2E$ per unit volume. This assumes that E is constant from zero stress to the limiting stress f, which is quite accurately true at ordinary levels of stress but might not be if f came out at a large value.

And if we equate the relevant strain energy to the relevant bonding energy, we do in fact come out with a large value of f, a value approximately equal to E, which is ten million pounds per square inch. Now, although the procedure here seems the most straightforward possible, there is a general, perhaps almost universal, belief that the answer is wrong, in fact that it is a whole order-of-magnitude too high, that it should be somewhere near one million pounds per square inch, not somewhere near ten million. There is a certain basis for this belief in the observation that failure under tension does not occur simultaneously at all parts of the fractured surface, like the one-hoss shay, but it begins at a single point and is propagated to others (with the characteristic velocity v_c, above mentioned).

This brings us to two theories which take account of this fact, the Theory of Dislocation and the Theory of Nucleation. Both of these theories, in their general forms, are at least twenty years old, I suppose, but both are recent as applied to the fracturing of glass.

In its most apposite form we find the nucleation theory in the work of Fisher[9] and others. Fisher postulates that the initiation and extension of a crack bears some analogy to the formation and growth of a cavitation bubble in a liquid. This theory leads to a value of strength somewhere near Nelson Taylor's, but it depends of course on an entirely different line of reasoning and an entirely different set of physical measurements, more nearly resembling those of the Inglis formula but in a different combination raised to different powers. The actual formula is

$$f \propto (E^2 \sigma^3)^{\frac{1}{5}} \qquad (5)$$

or in full,

$$f = \left(\frac{\pi^3 E^2}{6(1-\nu^2)\, kT} \cdot \frac{\sigma^3}{\log_e NkTt/h} \right)^{\frac{1}{5}} \qquad (6)$$

where f is limiting tensile stress, E is Young's Modulus, ν is Poisson's Ratio, σ is surface energy, N is Avogadro's number, h is Planck's constant, k is Boltzmann's constant, T is Kelvin's temperature, and t is the average time required to "nucleate" a single fracture or bubble in one mole of the substance.

Most of the quantities in this equation of Fisher's are "universal constants" whose values are accurately known, and Poisson's Ratio squared amounts to a relatively minor correction of about 5%. However, we once more have that most uncertain quantity, surface energy, coming into the formula. Fisher, in computing numerical results, takes σ as 200 ergs/cm^2. This is probably far too low a value at room temperature for dry glass, and we must either assume, in effect, that a crack is propagated at a very high temperature even in cold glass, or look askance at Fisher's numerical results.

Similarly, although Fisher's numerical results at room temperature, or Wiley's, who has checked them, agree fairly well with those derived from Nelson Taylor's formula, and with our best experimental results, Nelson Taylor cannot be quoted in Fisher's favor, for Dimmick and McCormick have shown that cracking velocity at 80° K is very nearly the same as at room temperature, and this means that Taylor's formula gives substantially the same strength at 80° K (liquid nitrogen) as at room temperature. But Fisher's formula and graphs show an enormous increase in strength at these low temperatures. Thus either Nelson Taylor's formula is inapplicable or Fisher's theory is wrong.

Since our perplexities are not resolved by the Nucleation Theory, though our admiration and appetite may be whetted by it, let us turn briefly to the Dislocation Theory.

Dimmick's finding that the cracking velocity decreases very slightly with increasing temperature has since been confirmed by Schardin. The fact that it is small may be construed to mean that it is of no *practical* importance, but that does not mean that it is of no scientific interest. It is just as necessary to account for a small change as for a large one, and it means that we may be able to choose among our theories of strength, if we can assume an organic connection between strength and cracking velocity.

At the moment I have little to add, but in the recent theories of the strength of metals, the "Theory of Dislocations" holds a prominent, and perhaps promising, place.* This theory is based on atomic structure, unlike the older theory of elasticity which in effect assumed a continuum and was therefore unable to deal with the more intimate aspects of fracture. In fact, the Theory of Dislocations assumes a regular lattice structure, and it assumes that distortional, or "shear", displacements on a lattice plane are the cause of creep and ultimately of failure.

Now it is quite difficult to see how such a theory can be applied to the brittle fracture of glass at room temperature, which is a tensile failure and not a failure in shear, so that it may be beside the point even to mention the matter. But the Theory of Dislocations, according to

* Cottrell, A. H. (1949) "Theory of Dislocations", being Chapter 2 of "Progress in Metal Physics", Edited by Bruce Chalmers, Interscience Publishers, New York, p. 77.

Mott and Nabarro[10], does seem to reach the conclusion that the yield strength of a metal should decline slightly with rising temperature, but that this decline should be at the most only a very few per cent as we go from absolute zero to room temperature.

This parallels quite closely the experimental results of Dimmick and McCormick, and of Schardin, using Nelson Taylor's theory of the connection between cracking velocity and strength, and it is tempting to speculate that the connection may not be entirely fortuitous. However, at this writing, it is no more than a speculation.

Some twenty years ago Schulz[11] was led to consider the variation of viscosity with temperature, and from it to deduce the strength of the molecular or polymer bond and the position of the ultraviolet absorption band. By a rather different course of reasoning, the present author[12] had come to consider the same things, and reached a not very dissimilar conclusion. But both these arguments lead to a higher estimate of strength than comes out of the Taylor and the nucleation hypothese. Yet the basic argument, that strength should be determined under ideal conditions by bond-strength and that bond-strength should be ascertainable by the absorption spectrum of a material like glass, or by a study of its viscosity at higher temperatures, appears to me fully as attractive as Taylor's ingenious argument by analogy.

It may be advisable here to mention that all this confusion is not peculiar to glass and silicates. Thus it is known that the practical limit of strength of sodium chloride is only about 0.2% of the value deduced from crystal lattice theory, and it is a matter of comment among metal physicists that the same thing is true of metals.*

We clearly need some synthesis which gathers up these various strands of thought, and indicates where our arguments are faulty and where they are sound, and the result would probably be a quick advance in our technology. All we have at the moment with any assurance is that the strength of glass is either 100 or 1000 times as great as the products of Pittsburgh Plate would lead you to suspect—*and this is one of our finest and most progressive glass manufacturers.*

Now what I have been trying to tell you is that we do not really understand the breaking of glass. I hope this is the third time I have said that, and that therefore it is exactly and perfectly true.

> "But I feel that in spite of all possible pains
> I have somehow contrived to lose count
> And the only thing now is to rack my poor brains
> By reckoning up the amount."[13]

I have sought it with thimbles and sought it with care, and you see it has got me exactly nowhere.

Mr. Chairman, I perceive from the glint in their eyes that the audience is getting ready to lynch me. There is but one wise thing left for me to do. I must softly and silently vanish away and never be seen here again.

* Andrade, E. M. da C. (1950) "The Physics of the Deformation of Metals", Endeavour, Vol. 9, p. 165.

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DR. SCHOLES APPOINTED DELEGATE TO INTERNATIONAL GLASS COMMISSION

Dr. Samuel R. Scholes, Sr., Associate Dean of the New York State College of Ceramics, Alfred University, was appointed a visiting delegate to the International Commission on Glass held in Paris, June 5 through 9.

Announcement of Dr. Scholes' appointment was made by Howard R. Lillie, President of the American Ceramic Society. Dr. Scholes represents the Society in the absence of Mr. Lillie, who is chief physicist at Corning Glass Works.

Twenty delegates from the United States, Belgium, the Netherlands, Great Britain, France, Germany, Italy, and Czechoslovakia are expected to attend the five-day session. English is the official language of the Commission. American members of the Commission are Mr. Lillie, D. E. Sharp of the Libbey-Owens-Ford Glass Company, and F. C. Flint of Hazel-Atlas Company.

The Commission, which works for international cooperation on glass research, was first organized in 1933. Dr. John C. Hostetter, one of the original organizers, is an honorary Vice President of the International Commission.

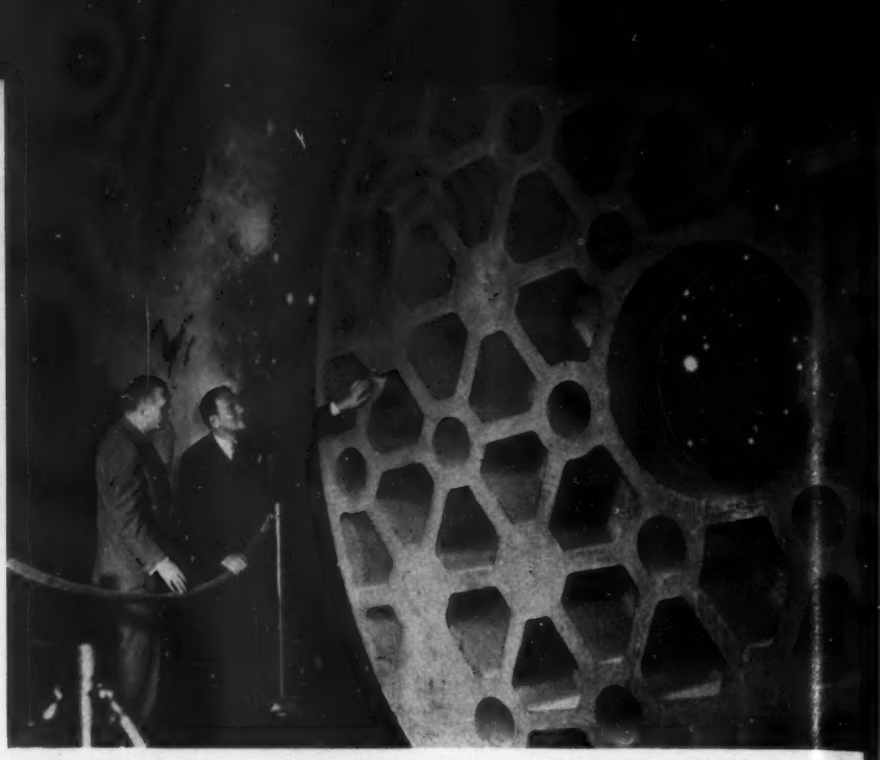
The aims of the organization are to stimulate cooperative effort in glass technology between different countries; to serve as an international center for the exchange of information on the art, science, and technology of glass; and to arrange for holding periodical International Congresses on glass.

J. L. CRAWFORD HEADS NEW REFRACTORIES INSTITUTE

A new trade association, known as The Refractories Institute, has been formed by the members of the refractories industry. The purpose of the Institute is to promote demand for the products of the industry, spur additional research with the objective of still further improving products and processes, and cooperating with government agencies in the interest of the public and the industry.

Approximately forty corporations representing the major portion of the industry have joined the new association. It has been announced that James L. Crawford, President of Walsh Refractories Corporation, and W. A. Turner of the McLain Fire Brick Company, have been elected President and Treasurer, respectively.

In the Corning Museum's lobby, a tiny, four-inch Egyptian amphorisk of the 18th Dynasty represents the earliest form of glass-making known to mankind.



In contrast to the delicate Egyptian vase, this 200-inch, 20-ton telescope disc bridges a gap of 3,500 years. Chairman Houghton of Corning watches as Governor Thomas E. Dewey proves to himself that the disc is really glass.

As the visiting press looks on at the opening of the Corning Glass Center, Arthur A. Houghton, Jr., and oldest Gaffer P. J. Hansson demonstrate part of the process involved in producing a piece of fine, Steuben ware.

Foreign visitors at Corning included Santha Rama Rau of India, Antonio Carrillo Flores of Mexico, and Dr. D. W. Brogan of England.

Chairman Houghton addresses members of the press at the Glass Center opening by outlining briefly the collections and facilities that will be available to research student, scholar, collector, and general public.

GLASS CENTER DEDICATION DRAWS NATIONAL LEADERS TO CORNING

The Centenary Cup being engraved for presentation to H.R.H. Princess Elizabeth on the occasion of the opening of the Exhibition of Exhibitions of the Royal Society of Arts. In height the Cup measures nearly fourteen inches and the bowl section, which rises in a graceful curve, is held to the inverted base by laid-on fingers of glass.

In commemoration of its centennial year, Corning Glass Works dedicated its Glass Center at recent ceremonies which drew together some of the nation's top leaders in government, industry, education, science, and press. The three-day conference was culminated with the formal dedication of the Glass Center by Governor Thomas E. Dewey of New York.

Host to the gathered conferees was Amory Houghton, Chairman of the Board of Corning Glass Works. Sharing his duties as host were Glen W. Cole, Vice Chairman; Arthur A. Houghton, Jr., President of Steuben Glass, Inc.; William C. Decker, President of Corning; George D. Macbeth, Vice President and Controller; William H. Curtiss, Vice President and Secretary; Charles D. LaFollette, Vice President and Treasurer; Dr. Jesse T. Littleton, Vice President and Director of Research; William C. Taylor, Vice President and Director of Manufacturing; Dr. Eugene C. Sullivan, Honorary Vice Chairman; and Howard E. Bahr, Manager of Public Relations.

Under the program direction of Dr. Charles E. Odegaard, Executive Director of the American Council of Learned Societies, the sessions were divided into a series of roundtables and general conferences on various phases of the humanities as they are influenced by and as they influence industrial civilization.

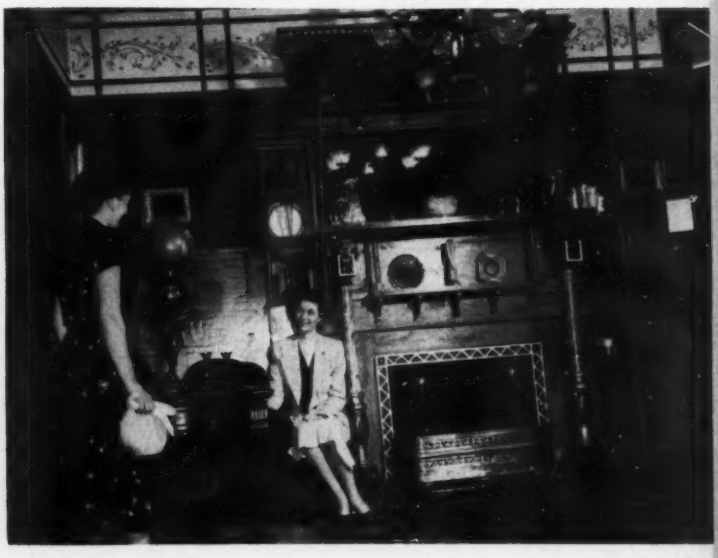
Leading glassmen attended the conference and took active part in roundtable discussions. Among those participating were Harold Boeschenstein, President of Owens-Corning Fiberglas Corporation; Henry B. Higgins, President of Pittsburgh Plate Glass Company; William E. Levis, Chairman of the Board of Owens-Illinois Glass Company; and Harry H. Cook, International President of the American Flint Glass Workers' Union, A.F.L.

The Corning Glass Center is the result of the company's desire to contribute something enduring to industrial research in not only the scientific aspect, but also

(*Continued on page* 316)

A section of the Museum of Glass which shows every significant use man has made of glass, disclosing every basic technique, skill, and formula ever used in glassmaking.

One of several period rooms at the Museum. This one is furnished with objects of the late 19th century. Others feature The Mauve Decade, Modern, etc.



THE PHYSICAL ASPECT OF GLASS-METAL SEALABILITY IN THE ELECTRONIC TUBE INDUSTRY

By GEORGES TREBUCHON AND JACQUES KIEFFER

TRANSLATED FROM VERRES ET REFRACTAIRES, DECEMBER 1950
By NORBERT J. KREIDL

PART III

Abstract

In the third part of an extensive study nomographs are given to translate data determined for standard samples to those of other dimensions as well as to those of identical shape but different diameter of metal lead.

Among the external variables investigated (atmosphere of annealing, humidity, electrical properties, thermal shock), the latter was emphasized. Axial compression is conducive to high thermal shock resistance.

The study concludes with a scheme of specifications for annealing cycles, sealing quality, and factory control.

SHAPE VARIABLES

General

The influence of geometrical form upon the strains developed in certain types of seals is the subject of the following paragraphs. For the sake of simplification the strains are treated in terms of optical path differences, but it should be remembered that in different shapes equal path difference does not necessarily mean equal strain.

The study considers simple types of seals from which are derived the main types used in current fabrication and suited for the so-called optimum annealing cycles defined in the preceding sections.

The materials constituting these seals will belong to two commonly used families of glass-metal pairs:

Glass A-119 (Bagneaux)—Molybdenum

Glass L (Bagneaux)—Dilver P (Imphy Steel Works.)

Each seal type is to be repeated for each type pair of materials.

Type A Samples

It has been shown that for these samples only the values for the path difference at ambient temperature and at 0°C. can be measured easily.

Figs. 40 and 41 express values of the path difference at 20°C. (δ_{20}) for samples A2, A1.5, A1, A.5 as a function of the δ_{20} values of the sample A2*, for the families of pair A-119—Molybdenum (Fig. 40) and L—Dilver P (Fig. 41), respectively.

These figures permit to derive from δ_{20} (A2), for a glass-metal pair of a given family, the values of δ_{20} (A1.5), δ_{20} (A1), δ_{20} (A.5), as well as, by interpolation, for intermediate radii, for all samples constituted from the same pair of materials.

The slope of the path difference cannot be obtained experimentally for these samples, but it is known through the theoretical relations

$$\frac{\delta}{BE_2d} = f \text{ (material characteristic)}$$

*One remembers that the symbol A2 signifies sample of type A with lead of radius 2. Analogous symbols refer to type B. δ_{20} (A2) means path difference at 20°C. of sample A2, etc.

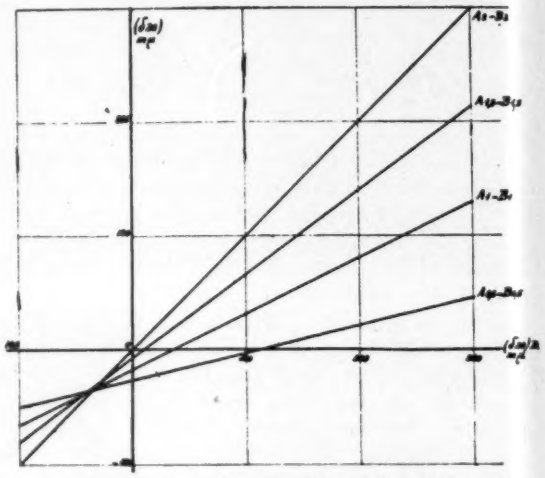


Fig. 40. Samples A and B. Family of pairs Glass A-119—Molybdenum. Values of path difference at room temperatures in different forms of samples A and B as a function of the path difference in B2: $\delta_{20\ a} \sim \frac{a}{2}[\delta_{20}\ (B2) + 35] - 35$.

established in Part I. These relations allow to determine from δ_{20} the complete polarimetric curves in the elastic range.

Type B Samples

Concerning values of δ_{20}, the same numerical results apply as for type A samples; and Figs. 40 and 41 remain valid and lend themselves to the same comments.

Concerning the values of δ at all temperatures, i.e., the polarimetric curves, this aspect has been examined in connection with the study of the correspondence of dilatometric and polarimetric experiments in the elastic range (Figs. 22-24).

Notes

The path differences δ_{20}, and therefore the strains, in different shapes are not always of the same sign for a given pair of materials, e.g., it so happens that a B2 sample glass A-119—Molybdenum gives a positive value of δ_{20} (B2), while the B.5 sample realized from the same materials gives a negative value of δ_{20} (B.5); similarly one may have for δ_{20} (B2) $= 0$, δ_{20} (B1.5, 1, .5) $\neq 0$. This is a very important fact to remember. Just as it has been stated before that neither the equality nor the inequality of the coefficients of expansion of glass and metal between 20 and 300°C. assures or disproves sealability, the path difference $\delta_{20} = 0$ for one form of sample does not assure $\delta_{20} = 0$ for other forms made from the same materials.

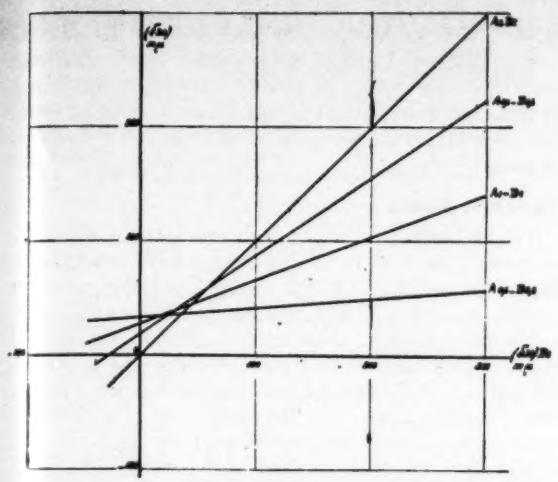


Fig. 41. Samples A and B. Family of pairs L—Dilver P. Values of path difference at room temperature in different forms of A or B type samples as a function of the path difference in the reference sample B2: $\delta_{20\ a} \sim \frac{a}{2}[\delta_{20}\ (B2) - 40] + 40$.

From Figs. 40 and 41 it may be seen that there is a zone where δ_{20} is essentially identical for all A and B type samples. It should again be emphasized that if all δ_{20} are identical, this need not be true for the polarimetric curves and the δ at elevated temperatures can be very different.

The preceding remark, and the measurement of the slopes in Figs. 40 and 41, permit to write in first approximation:

$$\delta_{20\ (a)} \sim \frac{a}{2}\,[\delta_{20}\ (2) - X] + X$$

where

a = form factor = radius of metal lead

X = numerical value for a family of material couples

One sees that $X \sim -35$ for the pair A-119—Molybdenum, and $X \sim +40$ for the pair L—Dilver P.

Type C Samples

For the family of glass L—Dilver P control problems incited our study of a third type of samples C illustrated in Fig. 42.

For this sample the path differences can be measured at all temperatures using a light ray grazing the metal perpendicular to the large faces and in the plane perpendicular to the large axis.

The trend of all results is identical with respect to path differences to that obtained on B type samples. It was considered unnecessary to reproduce them here.

Some Real Pieces

"Pinched Feet".

"Pinched Feet" (see Table 1. Type 11a) can be reduced to the type B sample under certain conditions. An analysis of the strain distribution was given by O. Adams.[10]

"Flat Feet".

"Flat feet" (see Table 1—Type 11b) can be reduced to the type A samples, under similar conditions.

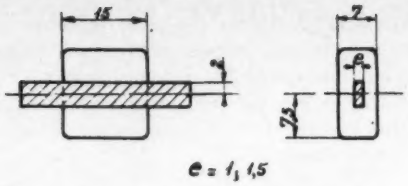


Fig. 42. Samples Type C.

"Riding" Tubular Seals (Table 1.—Type 323).

This seal is frequent, using Dilver P as the metal. The strain analysis alongside the metal is very difficult. In practice it is only possible to measure the path difference (Fig. 43) by a light ray traversing the two glass walls, grazing the metal and situated in a diametrical plane. This measurement allows to recognize the sign of a resultant acting on the glass tangentially at the point of grazing incidence. One says that the glass is "compressed" or "under tension" depending upon whether the resultant is revealed by a "high" or "low" color in the industrial polariscope.

This path difference can only be obtained at room temperature. The dependence upon the geometrical shape is very complex as variables such as the following (refer to Fig. 43) enter the picture:

H height of the cylindrical part of the glass sleeve.
h height of the cylindrical part of the metal sleeve.
E glass thickness.
e metal thickness.
ϕ means sleeve diameter.
l height of the penetration.

and many others.

The examination of these cases and the representation

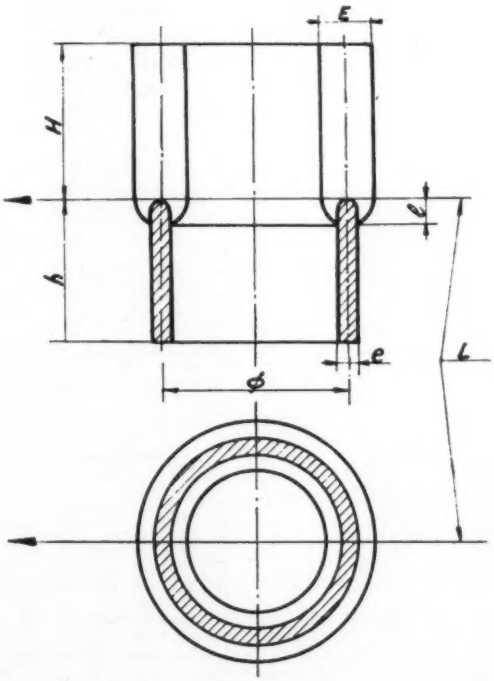


Fig. 43.

of experimental results as functions of such variables would exceed the scope of this study. It is perhaps unnecessary to comment on the range of such a study.

Fortunately it has become possible to recognize the most critical cases and to set down certain optimal conditions of form variables.

CORRESPONDENCE BETWEEN STRAINS IN STANDARD AND ACTUAL SAMPLES

This problem was again treated by the sole consideration of the path differences caused by the strains.

The interest to correlate the path difference obtained at ambient temperature in any piece with that obtained in a standard sample consisting of the same materials is evident. Therefore, the authors were induced to set up experimentally tables of correspondence for some important cases. As the standard was chosen the sample B2. The correspondence had sometimes to be established by passing through the observation of intermediates, in particular, type C samples.

It has been shown that $\delta_{20}\,(A_a) \sim \delta_{20}\,(B_a)$

Other relations have been established, particularly:

$$\delta_{20}\,(C_e) = f\,[\delta_{20}\,(B2)]$$
$$\delta_{20}\,(X) = f\,[\delta_{20}\,(B2)]$$

where X is the tubular "rider" seal.

INFLUENCE OF SOME EXTERNAL VARIABLES ON STRAINS

In this section some effects of climatic and functional conditions upon the strains, and, therefore, the solidity of the seals are indicated.

The study of these influences, which by the way has been advanced greatly, cannot be given *in extenso* here.

Atmospheres and Durations of Annealing

The experiments were carried out in air and commercial nitrogen with essentially the same results.

For conventional durations of annealing, and those up to 1 h, no particular destructive modification nor any strain changes due to oxidation or nitration were observed.

For very extended annealing times—larger than 10 hrs.—which are never used in practice, strong alterations of extremities and simultaneous variations (increases or decreases) of strain were noted which could also be explained by structural stabilization.[4, 5] This effect is not now to be considered in the industry.

Humidity

Seals from different materials held for 18 months at 70 ± 5°C. in an atmosphere of 90-100% humidity exhibited more or less pronounced breaks at the extremities, provoking strain in these regions. The unaffected parts show no change in strain. The destruction of adherence can become total in which case protection, under the general classification of tropicalization,[20] becomes necessary.

Thermal Shock

Thermal shock occurs if the temperature of the entire or part of the seal is rapidly modified by non-uniform application of heat. In both cases temperature gradients modify the intensity and even the distribution of strain.

The two principal cases to be considered are thermal shock on reprocessing and thermal shock due to electrical currents in service. In both cases the metal is heated faster than the glass. For the sake of simplification the metal is assumed to heat uniformly; the glass too, but so as to be retarded compared to the metal. The existence of more complex gradients is certain. They may aggravate or extenuate the shock. To treat this point one would have to consider the details of each sample or treatment.

The following reasoning holds for B type samples, with the understanding that in actual samples the strain formation is in the same direction, $d\delta/dT$ having the same sign regardless of configuration.

Essentially Constant Dilatation Coefficient.

It has been shown that, given the dilatation type of the glass, the polarimetric curves must have one of the forms of Fig. 44a,b,c, depending on the intrinsic material characteristics.

If one considers a seal in stock or service, its temperature being essentially uniform, one could think *a priori* that it is possible to realize it with a family of materials with one or the other form of polarimetric curve. It should suffice to choose the materials so that the amplitude of strains, e.g., between 0 and 300°C., should not exceed certain values.

However, if one considers the uniform thermal shocks described above the effect of which has been found to be that of a brusk increase in the dilatation of the metal, everything goes on as if the slope of the polarimetric curve had been decreased in its algebraic value as a consequence of the shock. The values of the strains can be related to a fictitious polarimetric curve (dashed in Fig. 44a,b,c, for a thermal shock produced at 20°C.).

In the case of Fig. 44a, the thermal shock caused a diminution in absolute value of strain, and rapidly, its passage through the value zero; in the case of Fig. 44b an increase in absolute value; in the case of Fig. 44c a small decrease, not tending to zero rapidly.

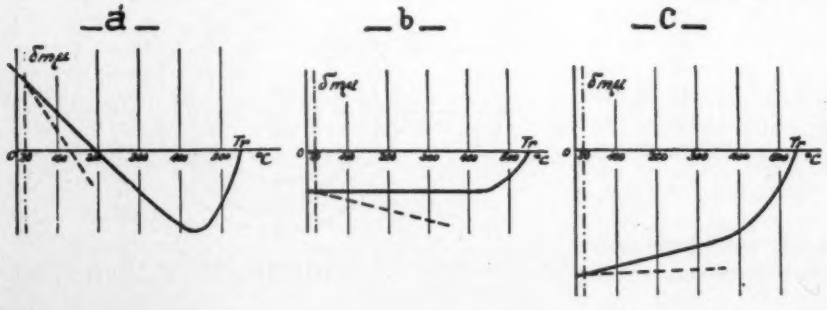


Fig 44. Samples B. Pair of Essentially Constant Expansion Coefficient. Effect of thermal shock on the path difference depending upon the type of the polarimetric curve (diminution of $d\delta/dT$).

In samples B2, and derived shapes, the criterion for thermal shock resistance can be expressed by postulating *the existence at ambient temperature of a path difference corresponding to axial compression.* In the case of constant dilatation coefficient of the metal, this condition is automatically accompanied by:

$$\left(\frac{d\delta}{dT}\right)_{20°} < 0.$$

Variable Coefficient of Expansion.

If one deals with a metal of the type Dilver P and any hard glass, with their great variations in characteristics, polarimetric curves of the various appearances of Fig. 45 a-g are obtained.

Under storage or service conditions again all seven types would be all right, provided the amplitudes were sufficiently reduced.

In the case of thermal shock, for reasons similar to those given above, only the first 4 types (Fig. 45a,b,c, d) cause a decrease in strain followed by passage through zero.

This family of materials therefore permits the same criterion of thermal shock resistance: *existence, at ambient temperature of a path difference corresponding to axial compression in samples B2.*

In practice, for Dilver P, the relation

$$\left(\frac{d\delta}{dT}\right)_{20°} < 0$$

is always satisfied.

Tubular "Riding" Seals.

For these seals an empirical explication can be derived immediately without resorting to the established tables of correspondence. If at room temperature the glass sleeve is "squeezed" by the metal, the fast rise of the metal temperature will first destroy this compression before tension is created. Therefore, "compressed" tubular "riding" seals support best thermal shock which corresponds to practical experience.

Electrical Phenomena

The phenomenon of discoloration of glass-metal seals by continuous or alternating electrical tensions have been known for a long time. This discoloration, which ends by becoming veritable destruction, is due to electrolytical migration of ions in the glass provoking at the seal oxidation or reduction and also a change in glass composition near the seal. Leaks and fissures are the consequence.[21,22]

Remarks

Regarding the effects discussed in the preceding paragraphs, one has to do with another group of glass properties (chemical stability, immobility of ions) as in the consideration of sealing properties (thermo viscosity, dilatation, elasticity).

Unfortunately these properties are complex from the viewpoint of the glassmaker whose task of satisfying the lampmaker is thereby made so much harder.

STRAIN TOLERANCES IN STANDARD SEALS

General

Considering the present stage of knowledge and the facilities available, the only approach for the determination of limits was the following:

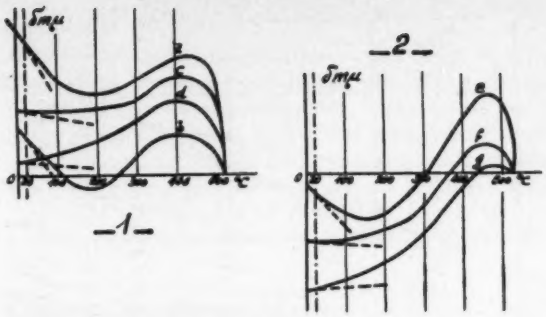


Fig. 45. Samples B. Variable Coefficient of Expansion. Effect of thermal shock on path difference depending upon the type of polarimetric curve (diminution of $\frac{d\delta}{dT}$.

(a) From a large number of polarimetric measurements on part assemblies and tubes, the results in usage and the laws of correspondence between path differences encountered in them and standard samples tolerance limits were deduced allowing economic production.

(b) Theoretical reasoning on standard samples and accounting empirically for the particularities of actual pieces, allowed to deduce other tolerances.

Both processes were carried out simultaneously and lead to similar results.

This discussion is to be limited to process (b) applied to two families of glass-metal pairs: A-119—Molybdenum and L—Dilver P, on samples B for the most common shape factors 2, 1.5, 1.

It is known that the resistance of glass to tension is small compared to that of compression. Therefore, only the limit of resistance to tension is to be considered. This resistance to tension as determined by many authors

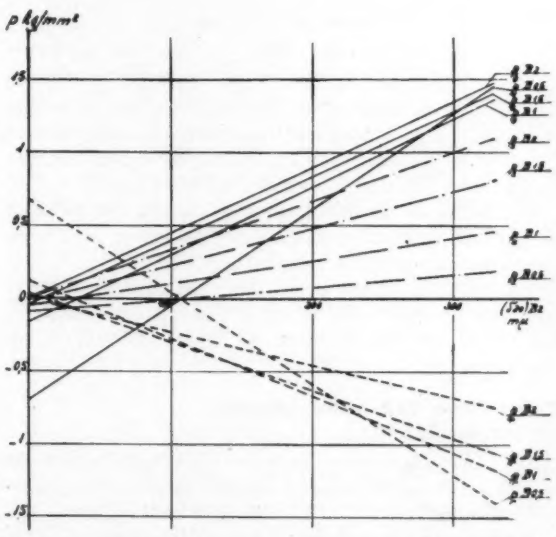


Fig. 46. Samples B. Family of Pairs Glass 119—Molybdenum. Values of maximum strains p_r p_δ p_z, at room temperature in different B type samples as functions of the path difference in the reference sample B2, δ_{20} (B2) in millimicrons, according to the relations $p = K.\delta/B$ and δ_{20} $(B_x) = f\ [\delta_{20}\ (B2)]$.

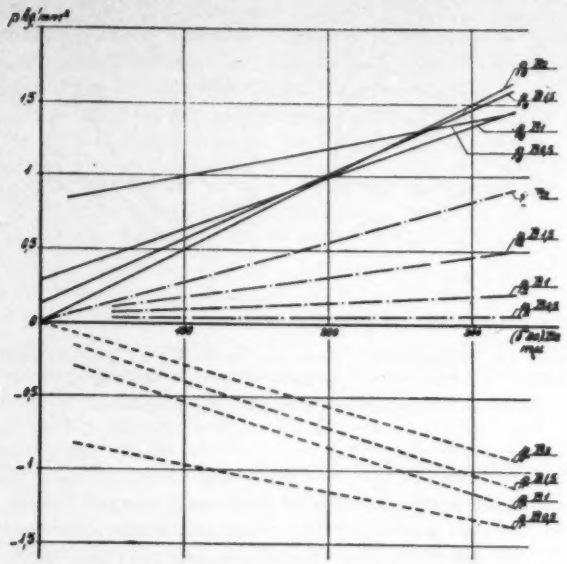


Fig. 47. Samples B. Family of Pairs Glass L—Dilver P. Values of maximum strains p_r p_ϕ p_z, at room temperature in different B type samples as functions of the path difference in the reference sample B2, δ_{20} (B2) in millimicrons, according to the relations $p = K.\delta/B$ and δ_{20} $(B_a) = f[\delta_{20}$ (B2)].

is found very variable, depending upon the testing procedure, the surface condition, the atmosphere, etc. The values of Winkelmann and Schott—3.6 — 8.5 kg/mm²—are adopted here. Since it appeared reasonable to maintain a safety margin, 2kg/mm² were next considered for calculation.

Now, the study of the distribution of strains on A and B type samples has shown that the strains are more important at the extremities than in the median plane where they are measured.[11] Therefore, the limit was set to 1kg/mm².

From the relations:

$$p = K\delta/B \text{ and}$$

$$\delta_{20}(B_a) = f[\delta_{20}(B2)],$$

which results from Figs. 40, 41, the Figs. 46 and 47 can be constructed that represent the maximum strains p_r p_ϕ p_z at ambient temperature in samples B as functions of δ_{20} (B2), for families Glass A-119—Molybdenum, and Glass L—Dilver P respectively.

The relations furnished by these figures can be used in first approximation to the development of strains at elevated temperatures in the elastic zone.

Finally, it has been established that in a glass-metal seal derived from types B and A the existence of radial tension at ambient temperature favors thermal shock resistance.

Pairs Glass 119—Molybdenum (refer to Fig. 46)

At room temperature the upper limit will be defined by the existence of a radial tension $p_r \geqslant -1$ kg/mm² corresponding to δ_{20} (B2) $\leqslant$ 280 millimicrons, the lower limit by the existence of a radial tension $p_r \leqslant 0$ corresponding to δ_{20} (B2) $\geqslant$ 35 millimicrons.

Given the respective types of absolute expansion curves of glass and molybdenum, the maximum path difference at elevated temperature must be negative and limited by the maximum tension $P_\phi \geqslant -1$ kg/mm² corresponding to δ_{20} (B2) $\geqslant -250$ millimicrons.

All sealable pairs then must satisfy the relations:

$$35 \text{ millimicrons} \leqslant \delta_{20}(B2) \leqslant 280 \text{ millimicrons.}$$

$$-250 \text{ millimicrons} \leqslant \delta T(B2) \leqslant 0 \text{ millimicrons.}$$

To account for variations in various lots of molybdenum and the approximations in the approach here presented, these limits are now reduced by one-fourth and the final tolerances for sealing glass A-119 and molybdenum become:

$$66 \text{ millimicrons} \leqslant \delta_{20}(B2) \leqslant 249 \text{ millimicrons}$$

$$-187.5 \text{ millimicrons} \leqslant \delta T(B2) \leqslant 0 \text{ millimicrons}$$

It also seems necessary for a good seal that the slope of the path difference be limited. Experimentally, this limit is found to be near .850 millimicrons/°C. for samples B2. Together with the existence of axial tension at room temperature this behavior seems favorable to thermal shock resistance.

These values are established for a glass having a Brewster coefficient 33.1 millimicrons /kg/mm²/mm; for glasses of the coefficient B they have to be multiplied by B/33.1.

Pairs Glass L—Dilver P (refer to Fig. 47)

At room temperature the upper limit will be defined by the existence of the radial tension $p_r \geqslant -1$ kg/mm² corresponding to δ_{20} (B2) $\leqslant$ 250 millimicrons, the lower limit by the existence of a radial tension $p_r \leqslant 0$ corresponding to δ_{20} (B2) $\geqslant 0$.

Given the respective types of absolute expansion curves of the glasses and Dilver P (see polarimetric curves), the largest amplitudes of path difference at elevated temperature must be so that the corresponding tensions are smaller in absolute value than 1 kg, i.e.

$$p_\phi \geqslant -1\text{kg/mm}^2, \text{ or } \delta_{20}(B2) \geqslant -170 \text{ millimicrons}$$

$$p_r \geqslant -1\text{kg/mm}^2, \text{ or } \delta_{20}(B2) \leqslant 250 \text{ millimicrons}$$

Therefore, all sealable pairs must satisfy the relations:

$$0 \text{ millimicrons} \leqslant \delta_{20}(B2) \leqslant 250 \text{ millimicrons}$$

$$-170 \text{ millimicrons} \leqslant \delta T(B2) \leqslant 250 \text{ millimicrons}$$

In order to make all metal-glass pairs seal, it is necessary to reduce this margin by 50% and the tolerances become:

$$62.5 \text{ millimicrons} \leqslant \delta_{20}(B2) \leqslant 187.5 \text{ millimicrons}$$

$$-85 \text{ millimicrons} \leqslant \delta T(B2) \leqslant 125 \text{ millimicrons}$$

The value of 125 millimicrons, found for δT (B2) can, however, without much danger be carried to the same limit as that for ambient temperature, namely, 187.5 millimicrons.

In this case it seems that in the elastic range slopes of 1.5 to 2 millimicrons/°C. can be tolerated.

These values were all established for a glass of the Brewster coefficient 39 millimicrons/kg/mm²/mm; for a glass of the coefficient B one has to multiply by B/39.

APPLICATIONS

This study has enabled the authors to attain all desired objectives. A scheme of the principal specifications are given in the following since, for reasons easy to comprehend, they cannot be given *in extenso*.

Specification of Annealing Cycles

In the second part of this study were given the purposes, advantages, and experimental prerequisites of this specification (characteristic temperatures of quenched glass by differential dilatometry, with the nature of glass and the dimensions of the sample deciding the cooling rate).

It was attempted to reduce the number of cycles to decrease the chance of errors and to unify operations, and to eliminate the needs for an operator except for loading and unloading.

In collaboration with "La Pyrometrie Industrielle", an installation meeting the latter requirement was constructed. Its brain is a program controller, with some artifices added.

Annealing from the ambient temperature.

The furnace is charged, the cam and holding temperature set, and the inverter to "automatic" positioned. When the starting button is pressed, the temperature rises at the normal speed of the furnace. When the annealing temperature is reached, the program controller is switched on automatically, maintains the holding plateau, and assures cooling at the predetermined rate. From the point from which cooling at any rate is no longer harmful, the pyrometer cuts automatically all heat supply (arresting temperature).

The arresting temperature can be chosen close to and below the annealing temperature, e.g., at $(T_r - 20)$ °C. Then cooling occurs in line with the inertia of the kiln.

Annealing of pieces introduced hot.

The kiln is heated, the cam set from the waiting temerature (T_r—30 to 40)°C., the program set for the annealing plateau, and the arresting temperature. The kiln first heats to the waiting temperature and remains there as on a plateau. After loading, the program controller is switched on automatically and controls first the programmed rise to the holding temperature, then the rest of the program like in the first case: hold, programmed cooling, total arrest of heat supply.

Quality Specifications

Quality specifications for glasses to be sealed with Molybdenum or Dilver P can be made by application of the results reported above and illustrated in Figs. 46 and 47. The measurement of the Brewster coefficient B of the new glasses allows to fix the value of the tolerances. The changes in the module of elasticity E_2 have no great influence.

The results obtained from the described metal-glass combinations can be equally applied to new materials, e.g., glass-ceramic seals, through a few supplementary measures and calculations.

For control purposes the leading factor is saving of manpower and use of automatic installations. Once a product is followed by the glassmaker and the metallurgist, only variations from defined values require control.

For metals one measures the path difference with a sample B2, using a standard glass, after three annealings:

(a) optimum

(b) from $T_r - 30$°C.

(c) from $T_r + 30$°C.

In practice it is enough to assure that the path differences obtained do not exceed the values fixed for δ_{20} (B2) for optimum annealing. For safety, all results on tolerances are based on a complete polarimetric curve.

For glasses, the method has been simplified by starting out with a strip fusion test with a standard glass. If this gives certain results fixed for each type in relation with polarimetric results, one runs a complete polarimetric curve.

Factory Control Specifications

Theoretically, since only inspected materials are used, the factory control can be limited to annealing quality. In practice, the measure of path differences permits to detect either poor annealing or defective materials. Doubts can be removed by a reanneal, and, if necessary, the preparation of A, B, or C samples.

For a new glass the determination of the Brewster coefficient allows to establish new tolerances with sufficient approximation. Also, for a new pair, extrapolation is possible after a few preliminary tests.

GENERAL CONCLUSIONS

It should be stressed that the present study of factors governing glass-metal seals was conducted as an industrial study from theoretical and, predominantly, practical viewpoints. All results are the outcome of hypotheses verified by five years of production experience, and many facts set forth by the predecessors of the authors between 1941 and 1945.

Measurements were made with industrial laboratory equipment that was at times insufficient to penetrate certain phenomena—e.g., the three dimensional photoelastic analysis—at times just able to produce relative values—e.g., Brewster coefficient—but that had at least the merit to yield results directly applicable to industrial production.

Thus, not all hypotheses could be pursued to purely scientific satisfaction. The investigation was halted where further development did not promise sufficient amelioration of production. This gives the laws derived a somewhat empirical character. The authors, while regretting this fact, suggest that other workers less concerned with immediate quality control, could continue or revise these studies and so furnish to the producers of lamps and the glassmakers better foundations which they could be happy to apply.

Acknowledgment. The authors are indebted to the Directors of the Societe Francaise Radioelectrique for the permission to publish this study, and to many others for advice and aid in measurements.

FOOTNOTES

[4]A. Winter-Klein—"The Physical Foundations of Annealing Glass", Bull. Inst. Verre., March 1946.

[5]J. Gillod—"Contribution to the Experimental Study of Structural Transformations of Glass", Verres et Refr., June 1949.

[11]R. Stanworth—"Strains in Glass Metal Seals etc.", Bull. Inst. Verre., November 1946.

[19]Adams—"Stresses in Two Wire Glass to Metal Seals", J. Soc. Glass Tech. *32* (145) April 1948.

[20]G. Trébuchon—"Tropicalization of Materials and Assemblies Utilized in the Construction of Electronic Tubes", Le Vide (26) March 1950.

[21]J. Peyssou—"Contribution to the Study of Electrolytical Phenomena in Glass", Ann. de Radioelectr. (12) April 1948.

[22]J. Gallup—"Electrolysis Phenomena in Soft-Glass Stems of Rectifier Tubes", J. Am. Cer. Soc., October 1946.

MORE ABOUT ALUMINATE GLASSES

The Editor
The Glass Industry

I should be glad if you would allow me to comment on the letter from Kuan-Han Sun published in your February 1951 issue. Dr. Sun has missed the points that I tried to make concerning calcium aluminate glasses and his remarks are therefore rather misleading. First of all he quotes a paragraph from my book but omits the last sentence, which reads "The mass of glass which may be formed completely without devitrification increased rapidly, however, with the addition of a few per cent of silica". The paragraph conveyed the fact that, although calcium aluminate will give glass *in small amounts*, the addition of quite small percentages of silica greatly increases the ease of glass formation. Perhaps I tried to say too much in too few words but reference was given to a much fuller discussion in my 1948 paper.

Sun also quotes from the same paper and concludes that I did not believe that calcium aluminate can be made into a glass. In fact I said in this paper that it was *known* from the work of Rankin and Wright (1915) that glasses were obtained during their study of the phase diagram associated with the calcium aluminate system, but there was no evidence as to whether or not the amounts of glass obtained were more than microscopic, nor was it clear if glasses could be obtained entirely free from crystalline material. The key to the confusion between us is quite simply the following: my own concern, as stated clearly in the above paper, is to discover whether a usable quantity of glass can be prepared, free from crystalline matter, as shown by X-ray diffraction tests. Many substances may be capable of forming microscopic quantities of glass if quenched in the manner employed in phase diagram studies but may be useless for preparing even a small disc of glass, and some substances may apparently form glass when X-ray diffraction examination shows them to be crystalline. In this connection I would quote a remark by Dr. Stevels (*J. Soc. Glass Tech.*, 1946, *30*, 53) when he said "It is a well known fact that a number of systems, especially those containing Al_2O_3, have a vitreous appearance but by X-ray analyses are recognized as crystalline".

Sun also concludes from my 1948 paper that I was not aware of the fact that many aluminate glasses had been made before my experiments. Once again I would emphasize that I referred to the work of Rankin and Wright. Reference was also made to the work of McMurdie and Insley on the system MgO, Al_2O_3, CaO, SiO_2. These authors mention the formation of glasses in *quenched* samples containing CaO, Al_2O_3 and MgO with only 5.8 and 6.0 per cent SiO_2, and in this case my experiments showed that discs of these compositions could be made of diameter 2″ without risk of devitrification, in contrast to the results obtained with pure calcium aluminates.

Sun then goes on to refer to various authors who have observed glass in quenched samples. These are irrelevant to the discussion in my paper unless evidence can be discovered that these authors obtained reasonable quantities of glass, free from crystalline matter when examined microscopically and by X-ray diffraction technique. Although the papers referred to were published many years ago, it is interesting to note that Morey in his comprehensive book (1938) did not refer to aluminate glasses, a fact which causes me no surprise!

There may be some interest in recalling why my melts of glasses based on calcium aluminates were made, as obviously they were made quite independently of Sun's work and, I imagine, for entirely different reasons. The reasons were in fact two:

(1) Because of the technical interest in checking whether usable discs of glass could be made from compositions known to give observable quantities of glass when quenched in the way used in phase diagram studies, and

(2) Because I had the thought that such glasses might have much better longwave infrared transmission than the silica glasses.

The infrared transmissions were checked immediately the glasses were prepared but the confidential nature of the work has prevented mention of the results until recently. The results showed that the glasses transmitted efficiently in a region of wavelength (5-6 μ) where silicate glasses absorb strongly and curves are shown in a paper accepted for publication in the "*Industrial Chemist*" a few weeks ago.

Dr. Sun makes a point of the fact that my book was published in 1950—that is after his 1949 article—but he is not aware of the fact that the chapter of the book concerned was *in print* in February, 1949, that is *before* his paper was published and that no changes could be made after that date even if changes were desirable. Dr. Sun is obviously quite ignorant of the difficulties under which British authors and publishers labor. His remarks about another British publication are irrelevant and his observation that the omission of the references on aluminate glasses was not due to time lagging during the publication is an incorrect conclusion formed by (rather surprisingly) generalizing from insufficient and limited knowledge.

Finally Dr. Sun apparently objects to my omitting a reference to his 1946 paper. I think this was quite in order as reference was made to his 1947 paper in the *Journal of the American Ceramic Society* in which Sun did go so far as to say (again without experimental evidence) that the composition $12CaO.7Al_2O_3$ forms a glass, whereas no evidence of the compositions of his glasses was given in his 1946 paper.

J. E. STANWORTH

* * *

The Editor
The Glass Industry

I appreciate greatly your kindness in giving me a chance to read Dr. Stanworth's masterly composed letter before its publication so that my answer can accompany his. I sympathize with Dr. Stanworth that because of geographical and time separations, a similar courtesy was not extended to him regarding my February 1951

Reference: December 1950, page 638, and February 1951, page 82, THE GLASS INDUSTRY.

letter to the Editor of THE GLASS INDUSTRY. The issue brought out in the last mentioned letter, as I have interpreted it, was whether Dr. Stanworth was aware of my two pertinent papers related to or on the subject of aluminate glasses published in the 1946 and 1949 issues of THE GLASS INDUSTRY and also of a U. S. Patent issued to me in April 1951, before he published his 1950 book.

If one dismisses the issue on the 1949 article and patent as due to my "insufficient and limited knowledge" on the difficulties encountered by or inefficiency of certain British publishers or as my erroneous concept of judging a basketful of apples by merely tasting a good one, then the issue of the 1946 article still remains. If Dr. Stanworth had seen the article during his researches on aluminate glasses or during the time of his book writing, he would not have said in his letter that he developed the aluminate glasses "quite independently" and perhaps a little later too. Apparently he was unaware of the 1946 article or purposely ignored it. If that was the case, it was certainly unfair to describe the situation as it has been done in a book put out by the Oxford University Press. More references, including that of an early U. S. Patent, were included in this early 1946 article than any mentioned subsequently either in Dr. Stanworth's book or other writings, and clear statements were also available in this early article on many different types of aluminate glasses being known before he made his. It may interest Dr. Stanworth to know that the aluminate glasses I made in early 1945, which were distinctly mentioned in the 1946 article, contain no glass formers, such as SiO_2, B_2O_3, P_2O_5, GeO_2, or others, whatsoever; and these glasses can be made into 2" or larger discs. With all modesty at one's command, it may be said that unless Dr. Stanworth was not interested in discussing the subject of aluminate glasses, ignorance of the 1946 paper was responsible for the loose attitude of the book and the misleading impression it conveys.

Dr. Stanworth brought out a basic issue regarding his concept of a glass. He feels that if one does not find crystalline phases in a substance by microscopic and x-ray diffraction examinations, he is satisfied to call it a glass. One probably would agree with him from a practical viewpoint. However, recent measurements by neutron diffraction method seem to indicate that a glass is composed of numerous minute crystals possibly of several atomic dimensions randomly oriented with respect to each other. If that is the case, one is almost certain to say that all the so-called glasses described in Dr. Stanworth's book are microcrystalline aggregates. Apparently a new definition for glass is needed before one would want to make any statement with an authoritative tone. It is irrelevant whether I myself favor the use of the limiting resolution of the x-ray diffraction technique as a tool in defining a glass arbitrarily.

Instead of wasting more of your valuable space and both Dr. Stanworth's and my own time, I only wish to say that now that facts and "misstatements" are all in print, the matter is up to the judgment of your intelligent and critical readers. Again, let me congratulate you in bringing out views from both sides, as you have always done in a controversial matter. I am sure your readers will take a similar impartial attitude in their opinions. It is unfair to Dr. Stanworth that I have taken advantage of writing this last letter (unless he writes again). But knowing Dr. Stanworth as one would through his book and above letter, I am almost certain that he seems as confident as I am in this matter. I will not be surprised if he agrees with me in leaving the matter up to your technical and scientific readers. I regret that all these letters, both Dr. Stanworth's and mine, constitute very little creative thinking and scientific endeavor, of which both Dr. Stanworth and myself should have devoted our full efforts. I shall close and end once and for all my comments here with due apology to Dr. Stanworth for having started all these time-wasting and seemingly unnecessary arguments and also with due respect for Dr. Stanworth's many outstanding accomplishments in the science and technology of glass.

Kuan-Han Sun

PITTSBURGH CORNING REPORTS NEW APPLICATION METHOD FOR GLASS INSULATION

Work at the Pittsburgh Corning Insulation Research Bureau has resulted in a method of applying, for the first time, the lower layer of cellular glass insulation to ceilings without mechanical support.

Because of the large thickness of insulation required in low temperature (below 50°F.) installations, the insulating material is usually applied in two layers. Previous to this new development, various sorts of mechanical anchors were employed to fasten the lower layer of insulation to the top layer. Tests at the Research Bureau now indicate that an average bond strength of 55 lbs. per square inch between layers of cellular glass insulation is assured when specifications are followed.

Although mechanical anchors are required to hold the top layer of insulation to the ceiling, the lower layer of insulation can be adhered with hot asphalt. It is important that the receiving surface be flat and even in order to obtain proper area of bond between the two layers of insulation. It is also important that the lower layer of insulation be applied to the receiving surface before the hot asphalt has set.

20% EXCISE TAX ON GLASSWARE BEING CONSIDERED

It has been reported that the House Ways and Means Committee is rumored to be considering a proposal to place a 20% manufacturing excise tax on all types of household furniture, floor coverings, and china and glassware. This will be a manufacturers' tax collected at the source, but will be billed to the retailer. The excise tax would also be assessed on imported goods, as well as domestic products, and for the same amount. The tax that now exists on luggage, jewelry, and other item is a retailers' excise tax collected by the retailer.

It is reported that $29,000,000 would be collected on the present volume of china and glassware from such a tax, although it is reasonable to assume that present volume would be reduced should this tax be levied. It is understood that the tax would not be applicable to industrial, scientific, laboratory, illuminating and technical glassware, nor to containers.

DR. SILVERMAN RETIRES AS HEAD OF CHEMISTRY DEPARTMENT AT UNIVERSITY OF PITTSBURGH

The retirement of Dr. Alexander Silverman as Head of the Chemistry Department of the University of Pittsburgh has been announced to become effective on June 13. Dr. Silverman will, however, teach one more class at the University, an 8-week course in beginning chemistry.

Dr. Silverman obtained his Bachelor of Philosophy degree at the University of Pittsburgh in 1902 and, following graduation, was employed as a chemist by the Macbeth-Evans Glass Company. He later entered Cornell University where he obtained the degree of Bachelor of Arts.

In 1905, he returned to the University of Pittsburgh as Instructor in Chemistry to serve under his former teacher, Professor Francis C. Phillips, then head of the Department of Chemistry. While serving in this capacity, he obtained the Master of Science degree in 1907. He later became Assistant Professor, Professor, and Head of the Department of Chemistry, which position he has held continuously for over 31 years.

Dr. Silverman has been an active member of the American Chemical Society. He is a past Chairman of the Pittsburgh Section and was councillor to the National Society for a number of years.

F. B. WOLCOTT NAMED GENERAL MANUFACTURING MANAGER OF WYANDOTTE

The appointment of Frank B. Wolcott as General Manufacturing Manager of Wyandotte Chemicals Corporation has been announced by Stephen T. Orr, Vice President-Manufacturing.

Mr. Wolcott was formerly in charge of manufacturing operations for the New Jersey Zinc Company. He joined the New Jersey Zinc Company as an engineer in the company's mines in West Virginia and in 1933 was transferred to the Palmerton, Pa., works where he was, successively, in charge of slab zinc and metal manufacturing until he became superintendent of the plant in 1948.

As General Manufacturing Manager, Mr. Wolcott will have supervision over the company's chemical, compounding, quarrying, mining, and transportation activities, most of which are in the process of expansion.

• Eugene F. Bertrand, Sales Manager to the Drug and Chemical Industries Divisions of Owens-Illinois Glass Company, has been appointed as Assistant Administrator of the Defense Production Administration. Mr. Bertrand, who will be on leave from Owens-Illinois, has the assignment of establishing and coordinating the activities of Regional Defense Mobilization Committees in New York, Boston, Philadelphia, Richmond, Atlanta, Cleveland, Chicago, Minneapolis, Kansas City, Dallas, Denver, San Francisco, and Seattle.

G.B.B.A. LAUNCHES GLASS HOBBY CONTEST

In line with its "promote glass" policy, the Glass Bottle Blowers Association has announced the development of a national "Glass Hobby" contest aimed, among other things, to bring to light many new and interesting uses for empty bottles. Many people have hobbies of building lamps with bottles as bases; others build ship models inside bottles. The prizes will be awarded for the most unique, interesting, decorative, or useful items made from empty glass bottles or jars.

First prize in the contest is a $500 bond; second prize, $250 in bonds; third prize, a $100 bond. There are six prizes of $25 bonds. Anyone is eligible to enter, except officials and paid employees of the Glass Bottle Blowers Association.

Entrants in the Hobby contest should send a description of their entry promptly to Glass Hobby Contest, 1133 Broadway, New York 10, New York. A snapshot or drawing of entries would be helpful, but is not essential. Entries selected for prize consideration will be notified to send in their finished entry for judging. The contest closes October 15, 1951.

Judges of the contest will include Lee W. Minton, President of the G.B.B.A.; J. R. Hainer, Jr., Editor of the *American Glass Review;* Arthur W. Kimes, Editor of *National Glass Budget,* and Cyril B. Delgado, Editor of THE GLASS INDUSTRY.

COLONEL KIMBLE RECEIVES S.A.M.A. AWARD

Col. Evan E. Kimble, pioneer glass manufacturer and founder of Kimble Glass Company, has received the Award for Outstanding Service given by the Scientific Apparatus Makers Association. The award was made at a special banquet during the recent meeting of the Association.

H. B. Richmond, Chairman of the Board of General Radio Corporation and past President of the Association, presented the engraved, leather-bound award certificate to Col. Kimble. In receiving the award, Col. Kimble was referred to as the person who, "more than any other individual, made America free of European influence in the availability of chemical glassware".

During the period following the close of World War I, Col. Kimble led the fight to protect American made chemical ware through tariffs so that the United States could remain free and independent from its former position of dependence upon foreign manufacturers.

STEUBEN RECEIVES CITATION

The American Institute of Architects has announced that a Citation for Craftsmanship has been awarded Steuben Glass in recognition of distinguished glassmaking. This award for craftsmanship, never before given to a corporation, was presented at the Institute's annual convention in Chicago, May 8 through 11.

Steuben has become widely recognized as the leading maker of fine glass in this country. Its greatest effort and attention has been devoted to the development of the three basic factors necessary in the creation of any object—material, craftsmanship, and design.

Inventions and Inventors

Annealing

Stacker Improvement. Fig. 1. Patent No. 2,549,663. Filed Dec. 28, 1945. Issued Apr. 17, 1951. Two sheets of drawings. Assigned to Emhart Manufacturing Company (formerly Hartford-Empire Company) by Stanley P. Clark.

The stacker used in this invention may be such as shown in Patent No. 1,905,476. The patent shows means for positioning bottles or other glassware so that they may be picked up two at a time and placed on the lehr conveyor. A reversible electric motor 13 is connected by a chain 30 with a spotting wheel 38 through a friction drive. Mechanism is provided to stop the spotting wheel periodically so that bottles coming in on the conveyor 51 will be pushed onto the dead plate 52 into position to be picked up two at a time by the duplex tongs of the well-known Hartford-Empire stacker.

The patent shows a modification of the invention and contains two claims. The references cited were 745,217, Mensing, Nov. 24, 1903; 1,009,090, Parker, Nov. 21, 1911; 1,116,558, Bruns, Nov. 10, 1914; 1,528,536, De Walt, Mar. 3, 1925; 1,878,156, Lorenz, Sept. 20, 1932; 2,209,858, Steiert, July 30, 1940; and 2,258,828, Trebert, Oct. 14, 1941.

Lehr with Shaping Mechanism. Fig. 2. Patent No. 2,551,311. Filed Aug. 26, 1948. Original filing date Sept. 9, 1943. Issued May 1, 1951. Nine sheets of drawings. Assigned to Toledo Engineering Company, Inc., by George W. Batchell.

This is an annealing lehr combined with bending means by which glass blanks in the form of sheets may be annealed and bent in one operation. The blanks are placed in a series of carriers suspended from endless chains 1 passing through the lehr so that they form a series of baffles transversely of the lehr tunnel. The tunnel is heated by burners discharging into tubes 24 so that when the blanks reach the shaping mechanism 14 near the middle of the lehr (shown in the figure) they are soft enough to be bent by dies 17 and 18. As each carrier reaches the proper point, it is lifted by a transfer mechanism 16 into position to be pressed between the dies after which it is returned to the chains and the temperature immediately starts to decrease to prevent the sheet from going out of shape. The regulated annealing temperature then continues and the blank emerges properly shaped and annealed.

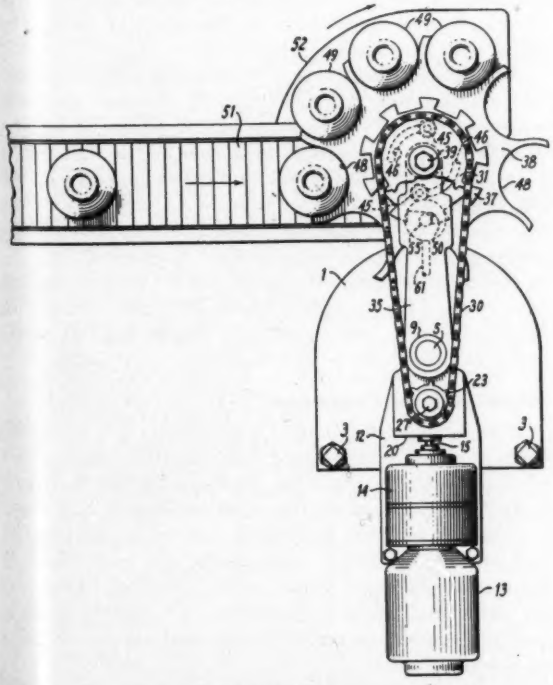


Fig. 1. Stacker Improvement.

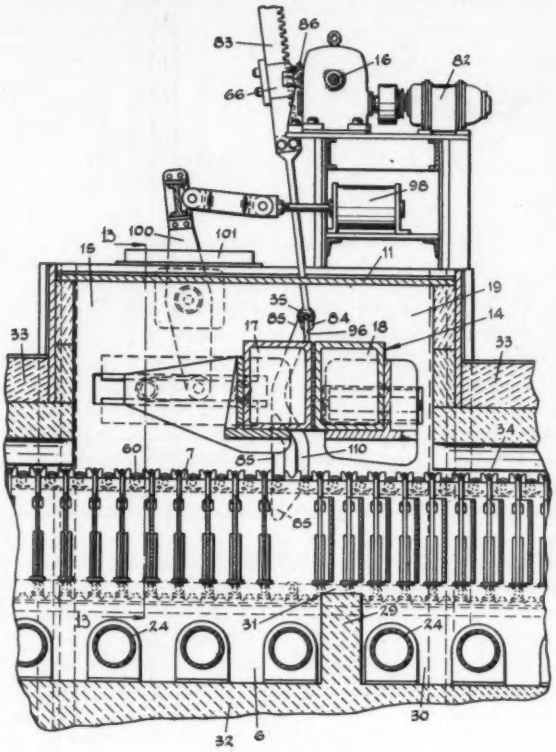


Fig. 2. Lehr with Shaping Mechanism.

The patent contains seven claims and the references cited were 1,125,468, Carnahan, Jan. 19, 1915; 1,259,459, Stile, Mar. 15, 1918; 2,057,763, Boyles et al., Oct. 20, 1936; 2,131,873, Goodwillie, Oct. 4, 1938; 2,176,999, Miller, Oct. 24, 1939; 2,251,159, Owen, July 29, 1941; 2,370,575, Owen, Feb. 27, 1945; and 2,377,849, Binkert et al., June 12, 1945.

Feeding and Forming

Vented Neck Mold. Fig. 3. Patent No. 2,550,140. Filed May 27, 1948. Issued Apr. 24, 1951. One sheet of drawings. C. L. Dotson, Washington, Pa., inventor.

The figure shows a section of a neck mold or neck ring 1 having screw threads 11 to form the finish by

Fig. 3. (Below) Vented Neck Mold.

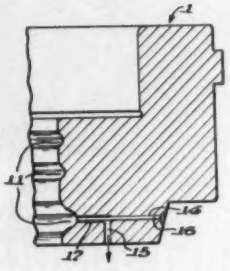
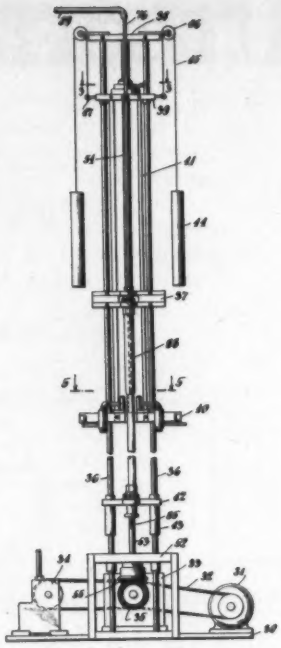


Fig. 4. (Right) Tube Forming Machine.



which the cap can be attached. In order to prevent air from being entrapped when the glass is pressed into the threads, a hole 14 is drilled into the side of the ring and connected with the bottom of the ring by a hole 15. In order that the opening shall be small enough to prevent glass from entering, a rod 16 slightly smaller than the hole is inserted. This leaves an annular opening only about .0015 inch wide which permits the escape of air but is too small to permit the entrance of glass.

The patent contains two claims and the references cited were 215,869, Bodine, May 27, 1879; 1,955,765, Peiler, Apr. 24, 1934; 2,078,919, Bates, April 27, 1937; and 2,266,831, Tegarty, Dec. 23, 1941.

Glass Compositions

Welding Glass. Patent No. 2,552,125. Filed Feb. 4, 1947. Issued May 8, 1951. One sheet of drawings not reproduced. Assigned to American Optical Company by Edgar D. Tillyer.

This glass is intended particularly for use by welders to cut down the glare while permitting good visibility of the work being performed. The patent has nine pages of specification giving numerous tables and complete information on the use of the invention.

The invention is summarized in Claim 1 as: A protective glass of the character described consisting essentially of a silica-soda-potash-lime base containing from 1 to 10 per cent by weight of iron oxide and a mixture of rare earth oxides as derived from monazite sand and including neodymium in proportion sufficient that it constitute from approximately 2 to 5 per cent of the glass, the silica content comprising at least half the glass by weight and said mixture of rare earth oxides and silica together constituting from approximately 60 to 85 per cent by weight of the glass, and the soda, potash, and lime constituting substantially the balance, said glass absorbing substantially all radiations in the ultraviolet and infrared regions of the spectrum and in the visible region having its maximum transmission on opposed sides of the sodium line, with substantially no transmission at said sodium line.

The patent contains seven claims and the references cited were 1,726,635, Taylor, Sept. 3, 1929; 2,219,122, Weidert et al., Oct. 22, 1940; and 571,017, Germany, 1933.

Glass Batch. Patent No. 2,552,495. Filed Sept. 20, 1947. Issued May 8, 1951. Two sheets of drawings, none reproduced. Assigned to Brockway Glass Co., Inc., by James P. Poole.

This batch is capable of very fast melting and fining and the resulting glass is of high quality. The invention is set forth in one claim as follows: The method of making a soda-lime type glass comprising mixing together the following ingredients in substantially the following proportons by weight:

Sand of minus 100 mesh	8000
Soda of minus 140 mesh	2669.7
Lime of 20 to 40 mesh	2059.6
Syenite	1021.3
Fluorspar	62.7

and melting and fining the same to form glass.

The patent contains seven claims and 13 references were cited.

Tube and Cane Machines

Tube Forming Machine. Fig. 4. Patent No. 2,552.108. Filed Dec. 4, 1947. Issued May 8, 1951. Assigned to Becton Dickinson and Company by Henry G. Molinari.

The object of this machine is to give accurate internal and external diameters to glass tube. An over-sized tube 88 is positioned between chucks carried by an upper carrier 37 and a lower carrier 42. The lower end of the tube is air-tight and the upper end is connected to vacuum by a pipe 89. The two carriers are counterbalanced by weights, the upper one by the weights 44 as shown. A cross member 40 carries a pair of burners by which the tube may be heated.

A threaded shaft 53 can be connected with a motor which causes the cross member 40 to move vertically while a mandrel within the tube remains stationary. The mandrel, which sizes the inside of the tube, has a longitudinal flat and is supplied with a lubricant. Thus the inside of the tube is brought to size due to the vacuum. For a complete disclosure of the invention, the patent, which has ten pages, should be studied.

The patent contains 18 claims and the references cited were 1,301,714, Kueppers, Apr. 22, 1919; 2,209,739, Meyer, July 30, 1940; 2,368,169, Smith, Jan. 30, 1945; and 2,393,979, Everett, Feb. 5, 1946.

Miscellaneous Processes

Ware Gauging Machine. Fig. 5. Patent No. 2,542,090. Filed Apr. 27, 1946. Issued Feb. 20, 1951. Four sheets of drawings. Assigned to Hartford-Empire Company (now Emhart Manufacturing Co.) by Edward H. Lorenz.

This is a machine for testing the sealing surfaces of jars or other articles to which a cap is to be applied. If this surface is out of shape so that a perfect seal cannot be made, the article is discarded. The machine might well be put into any line where finished ware is traveling on a conveyor.

The machine comprises an intermittently rotated tur-

ret T having eight ware-receiving pockets P. The ware 33 is positioned by rollers 30 and 32. The ware comes to the machine on a conveyor 37 and is guided to the turret by rails 35 and 36 which are adjustable to accommodate jars of different sizes. The jars are advanced by power driven pushers 43 mounted on a chain 45 and are pushed into the pockets on the turret. Fingers 50 prevent jamming of the ware.

A gauging mechanism G has a roller 61 which engages the outside of the finish of the ware while it is being rotated. If the ware is out of round, mechanism is set so that it will be ejected at a station R. If the ware is good, it passes back onto the conveyor through the guideway at the top of the figure.

The patent contains seven claims and 12 references were cited.

Lamp Sealing Machine. Patent No. 2,549,046. Filed Dec. 17, 1949. Issued Apr. 17, 1951. One sheet of drawings not reproduced. Assigned to Sylvania Electric Products, Inc., by Harold E. Baker and Charles A. Young.

This is a device for use in a lamp sealing machine for automatically positioning the exhaust tube and lead wires so that they will be accurately positioned in the final product. The lamp sealing machine may well be of the type shown in Patent No. 2,349,822. By the use of this invention, accurate bulbs may be produced at high speed.

The patent contains five claims and the references cited were 2,153,370, Donovan et al., Apr. 4, 1939; 2,212,842, McGowan, Aug. 27, 1940; 2,322,725, Bovio, June 22, 1943; 2,322,728, Gates, June 22, 1943; and 2,336,678, Gardner et al., Dec. 14, 1943.

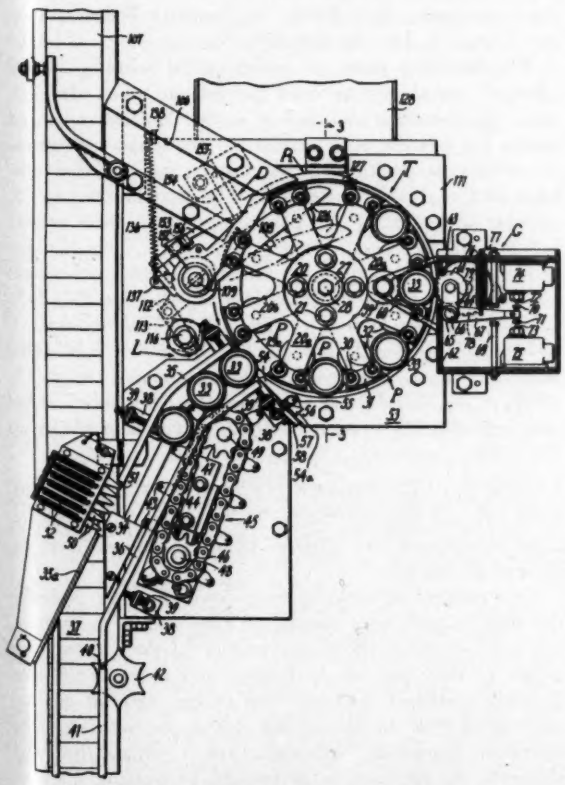


Fig. 5. Ware Gauging Machine.

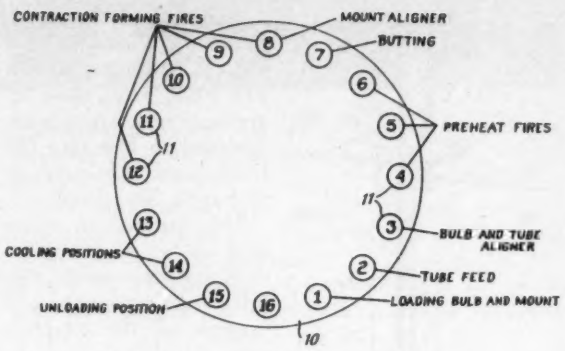


Fig. 6. Miniature Lamp Bulb Machine.

Stem Making Machine. Patent No. 2,549,296. Filed Sept. 21, 1948. Issued Apr. 17, 1951. Three sheets of drawings, none reproduced. Assigned to General Electric Company by Lee E. Dilts.

This is a device for use on high-speed machines for making stems for incandescent lamps, by which the presence or absence of lead-in wires may be detected and an alarm sounded or the machine brought to a stop. This prevents the loss caused by the production of imperfect stems.

The patent contains 15 claims and the only reference cited was No. 2,380,742 to Flaws dated July 31, 1945.

Miniature Lamp Bulb Machine. Fig. 6. Patent No. 2,549,359. Filed Feb. 7, 1945. Issued Apr. 17, 1951. Two sheets of drawings. Assigned to Tung-Sol Lamp Works, Inc., by Frank E. Bakanau.

The machine is adapted to sealing-in miniature incandescent lamp bulbs of the butt seal type. The machine is of the turret type having 16 stations where the bulb and mount holders subject the parts to operations as shown in the figure. The mechanism at each station is shown in detail in the patent. By this mechanism it is said that bulbs of greater precision and uniformity than heretofore possible may be produced.

The patent contains one claim and nine references were cited as follows: 966,571, Mickey, Aug. 9, 1910; 1,491,436, Strickland, Apr. 22, 1924; 1,716,167, Grogan, June 4, 1929; 1,742,153, Stiles et al., Dec. 31, 1929; 1,842,184, Madden, Jan. 19, 1932; 2,006,568, Gustin et al., July 2, 1935; 2,023,628, Van Sant, Dec. 10, 1935; 2,185,704, Donovan et al., Jan. 2, 1940; and 2,230,075, Chase, Jan. 28, 1941.

Method of Sealing Glass to Metal. Fig. 7. Patent No. 2,549,504. Filed March 15, 1946. Issued April 17, 1951. Two sheets of drawings. Assigned to Bell Telephone Laboratories, Inc., by Joseph P. Messana.

An eyelet 20, preferably made of "Kovar" alloy, and a conductor 22 of the same material and a ring 23 of hard borosilicate glass are mounted in a jig 24, 25. This jig is placed in a turret type machine having three working stations. At these stations the glass ring is heated gradually until, at the last station, burners 48 and 49 bring the glass to a temperature where it sags or flows to seal the two parts together. This is done without any pressing operation.

The patent contains eight claims and the references cited were 2,089,044, Thomas, Aug. 3, 1937; and 2,125,315, Ronci, Aug. 2, 1938.

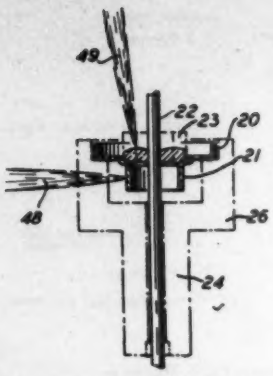


Fig. 7. Method of Sealing Glass to Metal.

Glass Mold Lubricant. Patent No. 2,549,535. Filed Feb. 11, 1949. Issued Apr. 17, 1951. One sheet of drawings, none reproduced. Assigned to Standard Oil Development Company by Arthur C. Skooglund.

This material is to be used as a spray or for swabbing glass molds. The following is given as one example of the composition:

95% by weight of naphthenic base lubricating oil, 40 S.S.U. viscosity at 210° F.

3% "Grafe" (10% suspension of colloidal graphite in oil)

2% isopropyl oleate

By the use of the composition of the example, it appears that the pores and imperfections in the metal surface of the mold are effectively covered because a wetting agent is used, so that they do not act as a drag against the molten glass when it is charged to the mold and spread over its surface.

The patent contains three claims and six references were cited as follows: 1,792,052, Wagner, Feb. 10, 1931; 1,879,874, Kidder, Sept. 27, 1932; 2,041,076, Lincoln et al., May 19, 1936; 2,246,463, Garratt, June 17, 1941; 2,256,603, Wright, Sept. 23, 1941; and 2,410,422, Breene et al., Nov. 5, 1946.

Tubulated Bulb. Patent No. 2,549,762. Filed Aug. 7, 1945. Issued Apr. 24, 1951. Expires July 26, 1964. One sheet of drawings, none reproduced. Assigned to International Standard Electric Corporation by L. C. Baker and J. F. Haines, both of London, England.

The invention comprises a jig to go in the headstock of a lathe, the jig having means to hold and center a glass tube and also having a mold portion. Another jib goes on the tailstock of the lathe. This jig cooperates with the first jig to mold a projecting tip on the closed end of the tube and to weld a small exhaust tubulation to the closed end which is opened by air pressure. Suitable heating and driving means are provided. The bulb thus formed has walls of uniform thickness throughout, which is a decided advantage.

The patent contains seven claims and eight references were cited as follows: 1,547,706, Whitmore et al., July 28, 1925; 2,100,656, Donovan et al., Nov. 30, 1937; 2,151,840, Dichter, Mar. 28, 1939; 2,169,315, Yngve, Aug. 15, 1939; 2,270,162, Margitta, Jan. 13, 1942; 2,272,927, Stager, Feb. 10, 1942; 2,306,163, Greifendorf, Dec. 22, 1942; and 2,350,220, Ehret, Jr., May 30, 1944.

Glass Bending Mold. Patent No. 2,550,252. Filed Dec. 7, 1942. Issued April 24, 1951. Two sheets of drawings, none reproduced. Assigned to Libbey-Owens-Ford Glass Company by J. E. Jendrisak.

This patent shows a bending mold adapted to carry a sheet of flat glass through a furnace so that it will conform to the shape of the mold, this mold being formed of sheets of material such as "Marinite" made by the Johns-Manville Company. These sheets are bolted together, have a high insulating value, and can be easily cut to shape. The heating and bending are performed in about the usual way.

The patent contains one claim and nine references were cited as follows: 760,959, Connington, May 24, 1904; 991,025, Robier, May 2, 1911; 2,137,115, Marshall, Nov. 15, 1938; 2,213,406, Paddock et al., Sept. 3, 1940; 2,261,033, Marshall, Oct. 28, 1941; 2,317,904, Galey, Apr. 27, 1943; 2,348,279, Boyles et al., May 9, 1944; 2,372,418, Forbes et al., Mar. 27, 1945; and 510,254, Great Britain, July 31, 1939.

Manufacturer of Thin Glass Sheets. Patent No. 2,551,279. Filed June 11, 1949. Issued May 1, 1951. Two sheets of drawings, none reproduced. George R. Miller, Greensburg, Pa., inventor.

These sheets are of particular use as cover glass used on slides for microscopes. Such sheets are from .003 to .014 inch in thickness. According to the invention. a thin glass ball is formed by spinning the blow pipe to which it is attached and then burning a hole opposite the blow pipe. The ball is then put in a furnace and rotated rapidly so that a flat, very thin surface is formed opposite the blow pipe. The glass attached to the blow pipe is then cut off, leaving a dish-shaped piece, the bottom of which is cut into pieces of the desired size.

The patent contains five claims and the references cited were 629,555, Fanta, July 25, 1899; 1,474,403, Chaney, Nov. 20, 1923; 1,767,923, Githler, June 24, 1930; 2,178,226, Diels, Oct. 31, 1939; and 330,268 Great Britain, June 4, 1930.

Vacuum Tube Machine. Patent No. 2,551,402. Filed Sept. 26, 1946. Issued May 1, 1951. Two sheets of drawings, none reproduced. Assigned to Western Electric Company, Inc., by Ralph A. Vinson.

This machine seals an optical glass window into a "Kovar" metal cup as used in vacuum tubes. In general, the machine includes a carrier for the cup and means for heating it, a carrier for the glass and means for accurately positioning the glass on the cup where the edge of the glass is softened by the heat of the cup. A plunger then presses the parts together to form a seal between them.

The patent contains three claims and nine references were cited as follows: 195,994, Edwards, Oct. 9, 1877; 1,779,311, Gates, Oct. 21, 1930; 1,953,492, May, Apr. 3, 1934; 1,991,062, Philpott, Feb. 12, 1935; 2,125,316, Ronci, Aug. 2, 1938; 2,252,517, Marshaus, Aug. 12, 1941; 2,347,421, Little, Apr. 25, 1944; 2,415,867, Cartun, Feb. 18, 1947; and 2,480,364, Hansen et al., Aug. 30, 1949.

Jewel Bearing. Patent No. 2,552,381. Filed June 30, 1944. Issued May 8, 1951. Three sheets of drawings, none reproduced. Assigned to Bendix Aviation Corp. by George K. Porter.

This method of making glass jewel bearing includes the steps of heating a section of glass rod to the softening point, pressing the heated portion of the rod between a pair of dies and into a bushing, and at the same time forming a central opening. The excess material is then ground off from the unfinished side of the bushing. The operation known as "oliving", that is, giving the final shape to the opening, is performed by heating the sur-

(*Continued on page* 318)

Research Digest

New Calibration Method for Testing Sieves

While sieve analyses are widely used in the glass, ceramic, cement, abrasive, sugar, and other industries for measurement of particle size, the discrepancies in the results of different laboratories—such as those of buyer and seller—often result in rejected shipments and financial loss, as well as considerable ill will. These discrepancies are sometimes due to inadequate sampling procedures, but when good representative samples, or even the same sample, are used, the differences frequently remain. Apparently the greatest source of error in sieve analysis has been the evaluation of the size of the openings of the testing sieves used.

A simple, rapid procedure for determination of the effective opening of testing sieves has been developed by V. R. Dietz and F. G. Carpenter and is described in the March 1951 issue of the National Bureau of Standards' *Technical News Bulletin*. The new method, which employs calibrated glass spheres of graduated size, may be readily applied by anyone familiar with sieving procedures without the use of special apparatus. Use of this technique is expected to reduce markedly the discrepancies that now occur between sieve analyses made at different laboratories with different sieving equipment.

In sieve analysis, the finely divided or granular material is agitated on a sieve of known opening until substantially all the particles that are small enough to pass the openings have done so. The fineness of the material is expressed by the weights of the various fractions retained by the sieves of different sizes. It has been found that the shaking process can be carried out in a satisfactorily reproducible manner and that the weights of the fractions retained by the sieves can be determined without appreciable error. But measurement of the size of the sieve openings has always presented a problem.

The method now in use consists of the determination of the size of the average opening from microscopic measurements. This requires equipment and technique that many users of sieves do not possess. Moreover, for non-uniform sieves, the size of the average opening has no significance because the largest openings determine the fineness of the material that the sieve will pass.

The method developed at the Bureau, on the other hand, determines the *effective* opening of a sieve, that is, the opening corresponding to the largest size of the calibrated glass spheres that will just pass the sieve. This means that sieve analyses made at different laboratories with different sets of sieves, some of which may not even conform to specifications, can all be reported with reference to the same openings, and the discrepancies that now occur can be greatly reduced.

Evaluation of the effective opening of a sieve with the glass spheres is easily accomplished by sieving a calibrated sample of the spheres in exactly the same manner as in the usual sieve analysis. This sample contains a continuous distribution of sphere sizes. The weight percentage passing the sieve is evaluated, and the effective opening of the sieve can then be read directly from a calibration curve supplied with the sample. Once the effective size of each of a set of sieves is known, all sieve analyses made with the set can be corrected by a simple graphical process to give the same values as a set of standard sieves.

Glass beads of the type used for highway markings have been found a suitable source of glass spheres from 80 to 1,000 microns in diameter (U. S. sieves No. 170 through 18). Separation of the truly spherical beads from the others is accomplished by allowing the beads to fall on a slowly rotating disk set at a slight angle to the horizontal. A gentle blast of air starts the beads rolling, and the spherical ones quickly travel in a fairly straight path to the edge of the disk where they fall into a container. The imperfect spheres and jagged pieces roll more slowly, or not at all, and thus tend to remain on the disk longer. These are carried on with the turning disk and fall into the discard hopper. The jagged pieces are cleared away by a more vigorous blast of air.

Next, the mixture of glass spheres is carefully selected to obtain a continuous distribution of sizes. Individual samples for sieve calibration are then chosen from the master mixture in such a way as to contain the same continuous distribution of sphere sizes.

The calibration of the sphere sizes is obtained by actually measuring the diameters of selected samples of the spheres. The diameters are obtained from their projections on a screen. A total of 14,000 glass sphere diameters are required for each calibration. The reproducibility in the calibration of the glass spheres has been shown to be about 1 per cent of the size of the sieve opening. This is significantly less than the variation—from 2 to 7 per cent—allowed in the present specification for testing sieves.

For further details, see Methods of Sieve Analysis with Particular Reference to Bone Char, by Frank G. Carpenter and Victor R. Dietz, J. Research NBS, 45, 328 (1950) RP2143. A limited number of the calibrated glass-sphere mixtures are available at a charge of $10.00 each from J. M. Brown, Secretary, Bone Char Research Project, Inc., c/o Revere Sugar Refinery, 333 Medford Street, Charlestown 29, Mass. Purchasers are requested to report their experience in the use of these spheres to Dr. V. R. Dietz, National Bureau of Standards.

N.P.A. CADMIUM ORDER

The National Production Authority has asked members of the Cadmium Industry Advisory Committee for specific suggestions for modification of the N.P.A. cadmium order issued in January to conserve the metal for defense and essential civilian uses.

So successful has the order, M-19 (Cadmium), been in attaining its objective of building up substantial stockpiles of the metal, it was stated, that there are now on hand sufficient supplies to allow wider use of cadmium than is allowed by the order.

N.P.A. asserted that the full impact of military requirements for the aircraft program will probably not be felt until the last quarter of this year and, therefore, it is believed the requirements of the order may be modified temporarily. Industry representatives were asked for suggestions, which N.P.A. said will be carefully reviewed.

GLASS VALVES FOR VACUUM CONTROL

One of the problems encountered in vacuum practice is the ready and accurate control of gas flow into or through the system. It is important that the device used for such control should not be a source of contamination and should not liberate unwanted gases. The standard stop-cock normally used for this purpose has been found unsatisfactory because its grease seal does not permit application of the high heats necessary for degassing. This results in undesirable contamination while the grease itself is a source of trouble.

To overcome these and other difficulties, as well as to provide an improved seal, R. Forman of the National Bureau of Standards electron tube laboratory has developed a glass-seal type of valve which operates at pressures of the order of 10^{-6} mm of mercury. The new valve depends on the expansion of glass or metal when heated. This elongation characteristic is utilized to break a glass seal which separates the vacuum system from another of higher pressure. When the source of heat is removed, contraction of the glass reseals the system.

The valve has the appearance of a conventional water condenser with but one side-arm. It is made of 7052 hard glass, chosen because its coefficient of expansion matches that of a Kovar sleeve inserted into the outer jacket. The center tube is sealed at one end and terminates at the other end in a graded seal, permitting the incorporation of the unit into any Pyrex system requiring this type of control.

One of the properties of two optically polished surfaces is the enhancement of the intermolecular force which acts to hold the two surfaces in contact. Before incorporation into the system, the concentric tubes of the glass valve are carefully cut with a glass saw, and the surfaces are optically polished to a high degree of flatness. The ends are then placed in contact once again and are held in this position by the molecular force. A forepump is connected to the inner tube, and the unit is pumped to some convenient value of vacuum. With the external pressure and the intermolecular forces holding the cut sections together, the outer jacket is glass-welded with a sharp flame. At this stage, there are two forces on the inner tube: the molecular adhesion and the external air pressure. During the cooling process, contraction adds another force. The total effect of these forces makes the seal vacuum-tight.

Under standard operating conditions, the inner tube is

(Continued on page 320)

Fig. 1. Glass valve developed at the National Bureau of Standards for use in high vacuum or low pressure applications. Its operation depends on the expansion of glass when heat is applied. This expansion of the outer tube is utilized to open and close an optically polished cut in the inner tube (about three-quarters of the way up from the base of the tube). The insert in the outer tube is a Kovar sleeve which rapidly conducts the heat radiating from an induction heater to the glass. The resulting expansion opens the cut thus bringing about the valve action.

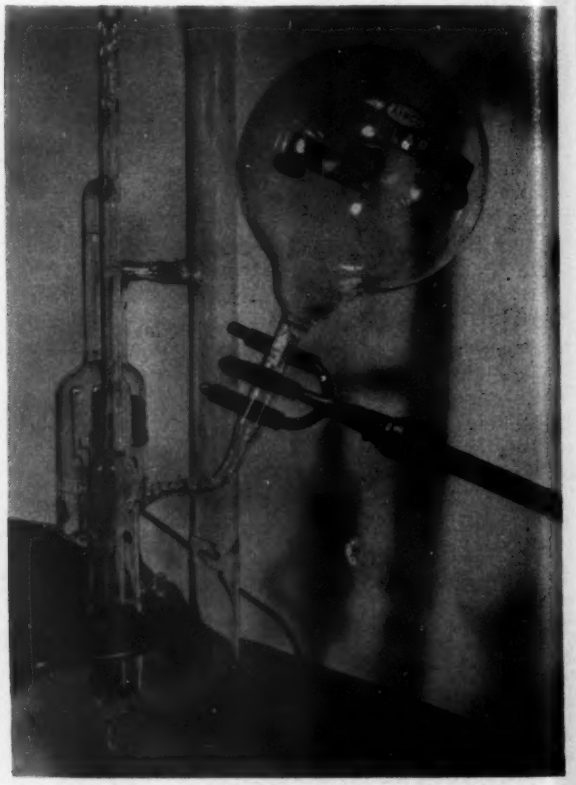


Fig. 2. The new glass-seal valve developed by the Bureau is employed in a vacuum system designed for gas admission. The operation of the valve (left foreground) is dependent upon the expansion of glass when heat is applied. A Kovar sleeve, inserted into the outer jacket of the valve, conducts the heat from an induction heater (coil around valve) into the glass jacket. The resulting expansion causes a molecularly sealed cut in the inner tube to open and admit gas from the gas bottle on the side arm of the valve. The tube directly behind the glass valve is part of an ionization gage used to detect the amount of pressure in the system.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during March 1951 rose almost 2½ per cent to reach a preliminary 130,000 employees. This is an increase over the previous month's adjusted employment figure of 127,100. During March 1950 employment had been 108,900, which is about 19 per cent below March this year.

During March 1951 payrolls were a preliminary $37,005,367. Compared with February's adjusted payrolls of $35,752,860, an increase of 3½ per cent it indicated. Payrolls during March 1950 were $27,884,576, or about 32 per cent below March 1951.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	April 1951
Narrow Neck Containers	
Foods	1,066,740
Medicinal & Health Supplies	1,309,706
Chemicals, Household & Industrial	686,442
Beverages, Returnable	602,746
Beverages, Non-returnable	14,229
Beer, Returnable	576,870
Beer, Non-returnable	612,780
Liquors	683,437
Wines	247,399
Toiletries & Cosmetics	558,967
Sub-total (Narrow)	6,359,316
Wide Mouth Containers	
Foods	2,217,379
Dairy Products	235,271
Home Canning	*
Medicinal & Health Supplies	377,376
Chemicals, Household & Industrial	136,868
Toiletries & Cosmetics	142,857
Packers' Tumblers	114,258
Sub-total (Wide)	3,224,009
Total Domestic	9,583,325
Export Shipments	264,584
TOTAL SHIPMENTS	9,847,909

* This figure included with "Wide Mouth, Foods".

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production April 1951	Stocks April 1951
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	4,061,092	3,309,280
	Wide Mouth	3,429,571	3,414,233
Dairy Products		246,906	301,444
Home Canning		*	*
Beverages, Returnable		737,085	644,321
Beverages, Non-returnable		20,043	24,767
Beer, Returnable		643,519	215,689
Beer, Non-returnable		669,201	202,007
Liquors		838,890	749,760
Wines		277,505	292,903
Packers' Tumblers		151,547	138,971
TOTAL		11,075,359	9,293,375

* This figure includes "Wide Mouth, Foods".

Glass container production, based on figures released by the Bureau of Census, continued its upward trend and production of 11,075,359 gross during April 1951 came close to setting a new all-time high (present high stands at 11,154,977 gross reported for the month of January 1947). Compared with March production of 10,986,549, April shows an increase of almost 1 per cent. During April 1950 production was 8,420,481 gross, or about 31½ per cent below April this year. During the January-April 1951 period, glass container manufacturers have produced a total of 41,541,413 gross. Compared with the 31,908,484 gross produced during the corresponding period in 1950, production for 1951 is 30 per cent ahead of last year.

Glass container shipments for April 1951 leveled off a little to reach 9,847,909 gross, compared with shipments during March of 10,523,045 gross—a difference of close to 6½ per cent. Total shipments of glass containers thus far during 1951 have reached 38,862,479 gross. Compared with the shipments of 30,681,538 gross at the close of the same period in 1950, shipments are about 26½ per cent higher than for last year.

Stocks on hand at the close of April 1951 are 9,293,375 gross—about 14½ per cent higher than the 8,090,693 gross on hand at the close of March. Stocks on hand at the end of April 1950 were 10,006,167 gross.

Automatic tumbler production for April 1951 was 7,533,507 dozens. During March production had been 7,570,422 dozens—only about ½ of 1 per cent higher than for April. During April 1950 production was 6,515,398 dozens. Shipments of automatic tumblers also showed a drop and were 6,851,240 dozens for April. This is a little more than 4 per cent below the previous month's shipments of 7,155,777 dozens. During April 1950 shipments were 6,167,764 dozens. Stocks on hand at the close of April were 10,932,953 dozens. Compared with March stocks of 10,340,140 dozens, a rise of about 5½ per cent is indicated. Stocks on hand at the close of April 1950 were 9,937,696 dozens.

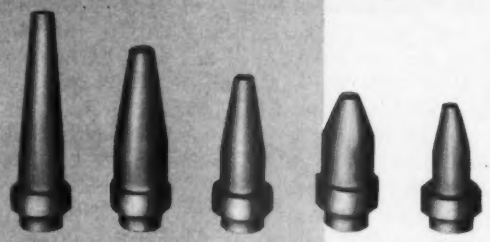
Table, kitchen, and household glassware: Manufacturers' sales of machine-made table, kitchen, and household glassware during April 1950 dropped 14 per cent to reach 3,438,850 dozens. March sales were 3,998,495 dozens. During April 1950 sales had been 3,265,924 dozens. At the close of the 12-month period ending April 1951, manufacturers' sales have reached 40,912,158 dozens. This is about 4 per cent above the 39,293,995 dozens sold during the corresponding period ending April 1950.

ERRATA

Erroneously the picture on the front cover of the May 1951 issue of THE GLASS INDUSTRY was credited to the Libbey Glass Division of Owens-Illinois Glass Company. This credit line should have read, "Courtesy of Glass Crafts of America", which organization promotes handmade glassware.

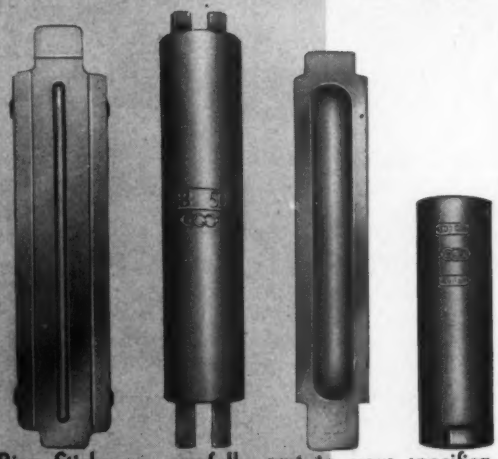
GUNITE

PLUNGERS



Standard plungers in all sizes from MG1 to MG10. Easily machined and polished to a mirror finish.

RING STICKS



Ring Sticks are carefully cast to your specifications from your own patterns. Readily machinable.

BAR STOCK

Round bars in standard 14 inch lengths. 1/2 inch diameter to 5 inch diameter by 1/4 inch increments.

ALL GUNITE castings are made of Gunite Metal suitably alloyed to provide the ideal glass house material. Gunite Metal is easily machined and readily polished to a mirror finish. Gunite Metal has maximum resistance to heat checking under the severe conditions imposed by glass making operations. You'll get superior service from GUNITE.

GUNITE FOUNDRIES CORPORATION

ESTABLISHED IN 1854

ROCKFORD GUNITE ILLINOIS

The cup held above by Miss Jane Barstow of the General Electric Company represents the fulfillment of an engineering dream. The handle of the cup is a metal spoon, soldered to the glass by engineers of the G-E General Engineering Laboratory in a process that permits the direct joining of glass to a metal. The bond formed by the process, briefly outlined below, is stronger than the glass itself, according to the engineers. The method, which can also be used to solder metal to ceramics and carbon, was originated by scientists of the G-E Research Laboratory, and is currently being tested for industrial applications in the General Engineering Laboratory.

G-E DEVELOPS NEW GLASS-METAL PROCESS

General Electric Company engineers have developed a process by which glass can be soldered to metal making a bond stronger than the glass itself.

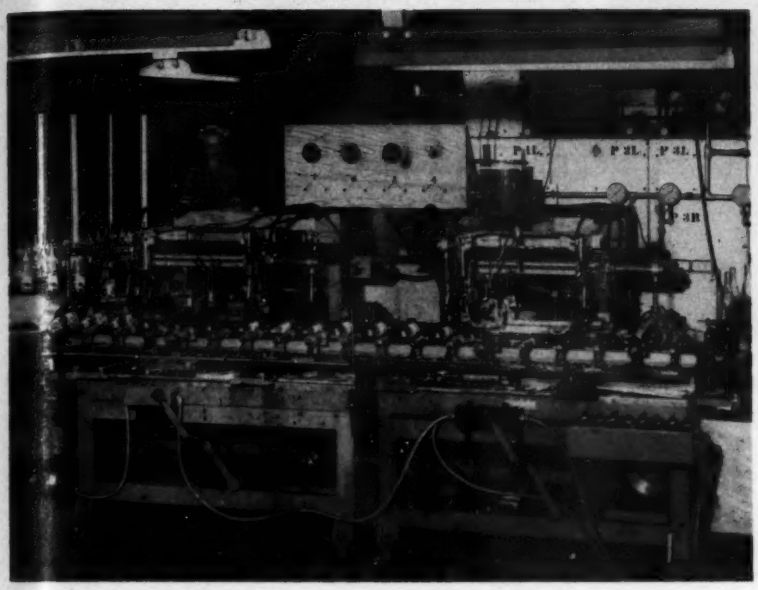
The glass and metal areas to be soldered are painted with a thin layer of titanium hydride, and solder is placed upon both painted areas. The parts are placed together and then heated under a vacuum.

When the temperature reaches about 900°F., the titanium hydride decomposes. This causes the solder, which has already become molten, to adhere to the titanium-painted areas of both glass and metal. A strong, tight bond is formed upon cooling.

By using soft metal solders, it is possible to subject this glass-metal seal to rapid temperature changes without danger of cracking, despite the wide difference in temperature expansions between glass and metal. This is possible because the differences in movement are absorbed by the solder.

• Benjamin A. Hammer has been appointed Manager of the New York Fiberglas Building to succeed Harold R. Holmyard, resigned. Mr. Hammer has been a member of Owens-Corning Fiberglas Corporation since 1947.

New Equipment and Supplies



AUTOMATIC SCREEN DECORATING MACHINE

Solar Engineering & Equipment Company, Beaver, Pa., has announced the development of a fully automatic screen decorating machine composed of four units for the decoration of beverage containers, milk bottles, certain types of food containers, tumblers, and other similar items.

The machine has a printing stroke from 0″ to approximately 14″ and has a variable speed control of from 1 bottle to 65 per minute. The printing stroke of the shoulder carriage is approximately the same as the body. The body and shoulder operating speed of the machine is around 55 to 60 per minute.

The first unit of the machine is the feed table which is merely a conveyor which feeds the bottles automatically into the unscrambler. The second unit, 8′ long, is the unscrambler which will place (not drop) the items to be decorated into the printing head. The third unit is the printing head (1 head per color) which is 4′ 10″ long. Any number of printing heads can be added by merely opening up the machine and fitting in the additional head. The fourth unit of the machine is the takeout, which will take the ware out of the machine, place it onto a conveyor, turn the bottle at a 90° angle, either to the right or left, onto a single line conveyor for feeding to the lehr. This section is 4′ long. At the end of the conveyor, which will be in front of the lehr, there is a power takeoff for an automatic lehr stacker.

The machine is fully cam operated even insofar as registration is concerned. Regardless of the number of printing heads used, the bottle is printed in the same direction in each printing head. This is desirable for registration purposes. On each printing head, there are only 9 wareholders. These can be changed quite readily when changing from one size job to another. With certain of the adjustments, the 9 wareholders can be changed simultaneously, it not being necessary to get the final adjustment on each individual wareholder. By having only 9 wareholders per printing head, extra wareholders for different size bottles can be adjusted readily.

The machine is primarily designed for use with thermoplastic color. However, regular cold medium colors can be used. If cold medium colors are used, it will be necessary to have a drying conveyor between.

CONTINUOUS SAMPLING METHOD OF QUALITY CONTROL

General Electric Company, Special Products Division, Schenectady 5, New York, has announced the development of a "continuous sampling monitor", an electrical device which automatically keeps track of sampling procedure.

The monitor was designed to eliminate the complexity of paperwork inherent in the continuous sampling methods of quality control. In operation, a given number of consecutive acceptable units is established by 100 per cent inspection. This "clearance" number and the percentage number to be used for sampling are determined by the desired average outgoing quality level, selected from a set of curves supplied with the equipment.

When the clearance number is reached, sampling begins. The prescribed percentage of units is inspected until an unacceptable unit is found. This defective unit is replaced by a good unit, and the 100 per cent inspection is followed again until the clearance is reached, at which time sampling resumes. This procedure continues. Each time a reject is found, it is replaced with a good unit, and 100 per cent inspection is followed until the clearance number is re-established.

BLAKE TYPE JAW CRUSHERS

Allis-Chalmers Company, Milwaukee, Wisconsin, has announced the application in the glass industry of its Blake type jaw crusher. The firm is supplying at least four 24 by 12-inch units with modified jaw plates to glass plants in various sections of the country to crush flat glass plate and lump cullet, according to the announcement.

The particular crushers employ a positive and economical pneumatic grease lubrication system. Compressed air at 100 pounds per square inch is delivered to the grease pump, which builds pressure up to 3,000 pounds per square inch and injects grease periodically to each grease fitting by means of a timer device.

The crushing chamber of the Blake jaw crusher consists of a stationary jaw plate held securely to the semi-steel main frame, and a swing jaw plate. This plate is carried by the swing jaw which is suspended by a heavy heat treated steel shaft from the main frame. A reciprocating motion is given the swing jaw by a double toggle and an eccentrically operated pitman linkage. A tension rod and spring hold the swing jaw securely against the toggles.

ELECTRIC FURNACES

Gilbert S. Simonski Company, 401 North Broad Street, Philadelphia 8, Pa., is offering any of its line of Lucifer Electric Heat Treating Furnaces on free trial to qualified furnace users.

Any Lucifer furnace may be used for regular hardening, case hardening, drawing, tempering, etc. New types of electronic controls on the furnaces permit any Lucifer furnace to be brought to the desired heat slowly or rapidly, as desired.

CATALOGS RECEIVED

Cambridge Wire Cloth Company, Cambridge, Maryland, has announced its Bulletin No. 98 entitled "Combine Movement with Processing."

The folder, devoted to the company's woven wire belt, features the Balanced Wire Belt and the Rod-Reinforced Belt. Data describes the advantages and applications of the two types of belts and a typical installation is illustrated. The bulletin shows several other available Cambridge wire belts.

EMPLOYEES HONOR BUCK GLASS FOUNDERS

On May 10, 1951, tribute was paid to the late Messrs. Laurance and George Buck, founders of the Buck Glass Company in Baltimore, Maryland, by the employees of the company.

In conducting this ceremony, Royden Blunt, President of the company, made the following brief remarks: "This ceremony we are about to witness, while not unique, occurs far too seldom in industry. It commemorates the lives of two men much loved by the people of this community and particularly of this company.

"It has been my pleasant privilege to be associated for twenty-five years with this company, and during that time a very close and cordial relation existed with the late Messrs. Laurance and George Buck. So I know something about how deeply many of you miss them. A description of these men for this purpose can be condensed to a remarkable degree and still give a complete picture of each.

"Mr. George Buck was the kindest man I've ever known. His brother, Laurance, had fewer faults and more virtues than anyone I've ever known. This ceremony has been kept simple and modest because that is the way they would have wanted it. Truly, it is a beautiful thought to be remembered in such an appropriate way by you who knew them best."

At the conclusion of these remarks, workmen attached the bronze plaque to the front of the office building, located above the historic old Fort McHenry. The ceremonies were confined to the Board of Directors and a Committee of the employees representing the various departments in the factories.

• The organization of a Conference on Light, to be held in Paris September 26 through 30, 1951, has been announced by Dr. W. Morikofer, President of the International Committee on Lighting.

• Edmund F. Ball, President of Ball Brothers Company, has been elected to the Board of Directors of Borg-Warner Corporation, succeeding his uncle, George A. Ball, who has retired as a Borg-Warner director.

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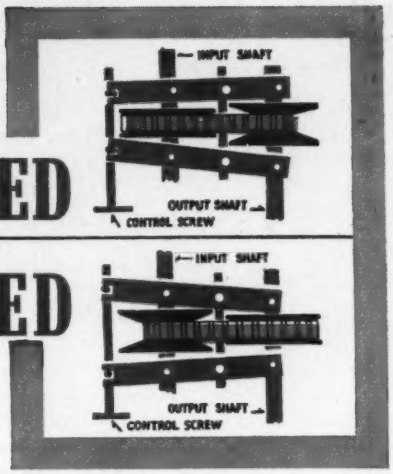

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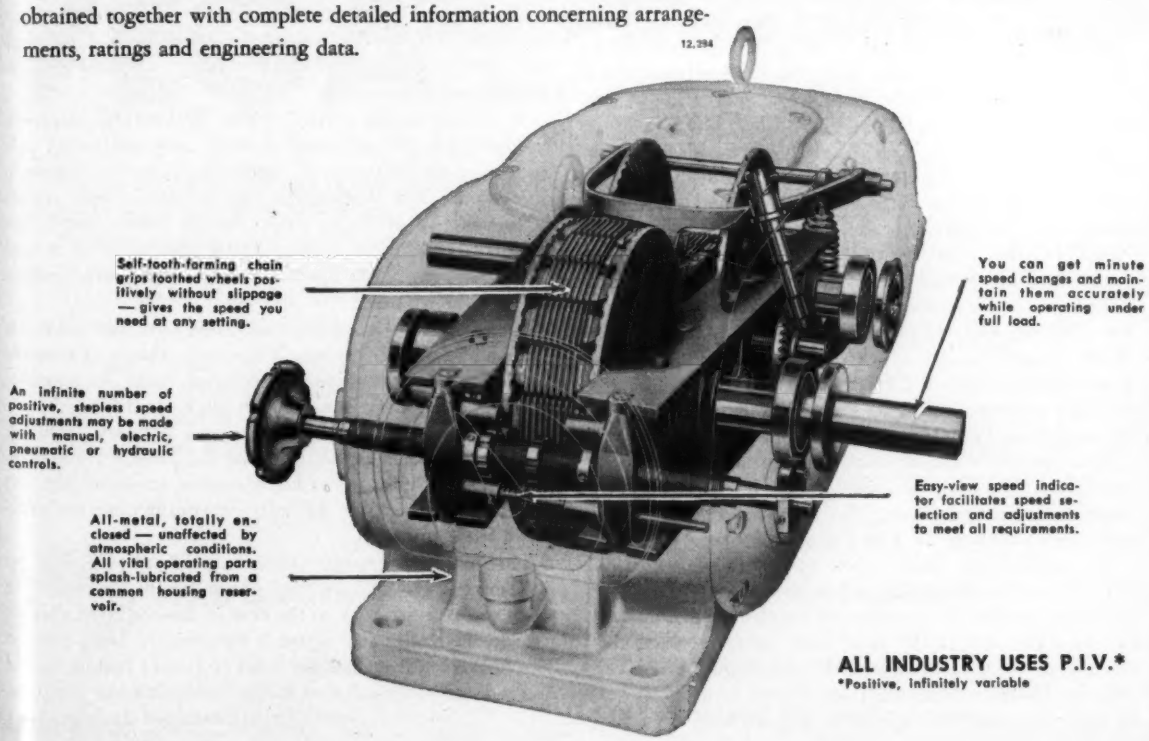
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G. C. M. I. MEETING . . .

(*Continued from page* 283)

of matters relating to finishes, some studies of which are aimed at clarification and simplification of basic specifications of the drawings of specific finishes.

Container Design

J. M. Foster, of Foster-Forbes Glass Company and Chairman of the Committee on Container Design and Specifications, together with the Chairman of the Sub-Committee on Beer Bottles, G. A. Mengle of Brockway Glass Company, and W. A. Seger, of Buck Glass Company and Chairman of the Sub-Committee on Milk Bottles, presented a full report for the period of November 1950 through May 1951.

Despite the fact that an N.P.A. limitation order has been effectuated for the purpose of simplification of glass containers under defense mobilization, the Committee on Container Design and Specifications has handled a great many problems during the past six months. Some of these matters are of long range importance, while others deal with the immediate needs of the military and current civilian requirements. Mr. Foster emphasized that his Committee was indebted to the Committee on Package Design and Specifications for its help on several difficult problems.

Package Design

The activities of the Committee on Package Design and Specifications, it was pointed out by its Chairman, G. C. Noblit of Brockway Glass Company, have reflected in many ways the changing national conditions and their effect on fiberboard and fiber box supply. The extent which any stringency of supply of these materials must have on the glass container industry was exemplified by Mr. Noblit's statement that this industry uses from fifteen to twenty per cent of the national container board production.

In his report, Mr. Noblit briefly sketched the paper board picture from before December 1950 and pointed out that while earlier in the year the National Production Authority characterized the paper board supply as "tight" rather than "critical", these officials strongly urged the glass container industry to do everything possible to conserve paper board. The Committee on Package Design and Specifications, recognizing that the "tight" supply might quickly deteriorate to a critical short supply, suggested to the industry as a whole that methods of conservation as recommended by the N.P.A. be considered by each individual manufacturer.

Two possible methods of conserving paper board were developed. The first was based on the idea of conserving paper board by increasing the number of certain glass containers packaged in a shipping container.

The second was based upon the effective use of the different grades and types of boards and upon the elimination of packaging in excess of requirements when this can be done and at the same time insuring a sufficient margin of protective safety for empty and filled containers. These recommended procedures would still have to meet the minimum specifications in Rule 41.

Many of the individual glass companies have formulated plans to make use of these methods in their conservation programs.

Other matters covered in Mr. Noblit's report were freight car surveys and railroad activities, laboratory studies of export packages, Consolidated Freight Classifications, Federal specifications relating to government buying, and the 1951 G.C.M.I. Color Chart. This chart incorporates several changes in the printing used by the glass container industry for shipping containers which have taken place during the last two years. The Committee feels that glass container manufacturers are giving more attention to their printing quality and felt that the changes which have taken place made it desirable that a new edition be issued by the G.C.M.I.

Recognizing that for the glass container industry to meet the demands for its products indicated by the National Production Authority, the Institute requested speakers qualified in their respective fields to discuss the glass raw material and glass machinery outlook.

Arthur W. Chadwick, President of Solvay Process Division of Allied Chemical & Dye Corporation, was the first speaker on this panel of six. His subject, of course, was the supply of soda ash. Mr. Chadwick quoted some interesting figures on the production and consumption of the prime material for glass and left his audience with the impression that, at least for the foreseeable future, the soda ash industry would not be too heavily taxed in meeting the glass container industry's requirements.

On the subject of light chemicals, R. R. Shively, Vice President of B. F. Drakenfeld & Company, Inc., ably outlined the supply position of various minor ingredients of critical, or may be said to be non-existent due to boycott by the Indian and Brazilian governments and its domestic use in rectifiers. Cobalt is in much the same category, as far as supply is concerned, while on the brighter side, the supply situation of cerium shows some good prospects as a result of expected production in California and Idaho. This ingredient may prove of great help as a substitute decolorizer.

V. V. Remington, also of the Drakenfeld company, followed Dr. Shively with a brief and interesting talk on the supply situation of vitrifiable colors for container decoration. Mr. Remington was optimistic with regard to the supply of many colors which would enable the industry to continue its decorating operations at a high rate. The picture for blue, however, is, of course, indeed blue.

While no one has been concerned with the available supply of good glass sand, Vincent P. Ahearn, Executive Secretary of the National Industrial Sand Association, held the glassmen's interest with his discourse on the potential problems of production and delivery—that is, manpower and transportation. At the present time, manpower at the sand pits is not a serious problem, but this could become an acute difficulty depending upon the overall defense program.

The matter of transportation is a difficult one now. It was pointed out that although the railroads are replacing worn out rolling stock to the best of their ability, this replacement is only just equal to cars retired from service. The broad requirements for steel and other factors would preclude an early solution to the transportation problem.

(*Continued on page* 312)

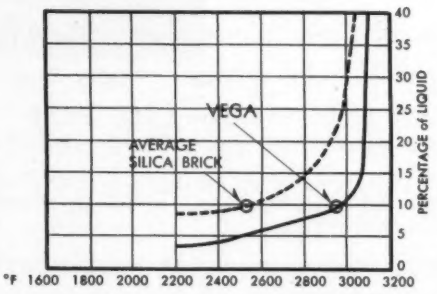
For higher temperature operations...

The Ideal Silica Refractory for Glass Tank Furnaces

VEGA *Super-Duty Silica Brick* AND VEGA BOND CEMENT

By providing longer service-life at higher temperatures Vega Super-Duty Silica Brick increases furnace production, and reduces maintenance. The ability of Vega to withstand higher temperatures is shown by the melting behavior chart at the right, and is confirmed in actual service by comparative operating records.

Vega Bond has excellent working properties—has the same refractoriness and thermal expansion as Vega brick—makes a strong tight bond with Vega and conventional silica brick.



Note that an average silica brick becomes 10% liquid at 2550° F., whereas Vega reaches 2970° F. before it becomes 10% liquid. This means that Vega permits furnace operation at higher temperatures—or an extended life at normal temperatures.

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Glass Tank Furnaces is the only book in the English language dealing comprehensively with glass tanks. Its contents include and describe in simple language, the most modern practices in design, construction, operation, behavior and economy of glass tanks. It is a book for the factory man, the technologist and for all who are interested in the practical aspects of glass making.

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G. C. M. I. MEETING . . .
(*Continued from page* 310)

Despite these troubles, Mr. Ahearn felt that the sand supply would be in a favorable position through 1953.

Morton S. Cressy, General Manager of Sales and Service, Hartford-Empire Division, Emhart Manufacturing Company, spoke to the glassmen of some of his company's problems in providing new equipment and parts under the restrictions on steel and other metals. He described Hartford's facilities as provided by the parent company's various divisions and assured the glassmen of the utmost cooperation.

Frank K. Zimmerman, newly elected President of Lynch Corporation, briefly outlined what the Lynch Corporation was doing to help meet the increased demand for glass containers. The Lynch Corporation, with its foundry and divisions, expects to deliver efficient service to the glass container industry.

The last speaker on the program, C. P. Overmyer, President of Overmyer Mould Company, presented some interesting facts concerning the supply of certain materials essential to glass mold production.

At the moment, pig iron, coke, several sands used in casting and mild steel have not been difficult to obtain and the supply has been ample to take care of the company's needs. It should be noted that the Overmyer foundry produces about twenty tons of marketable castings per day. About fifty-five to sixty per cent of the castings are for concerns outside of the glass container industry and some of the castings are going into defense work. On the critical list are nickel, molybdenum, and ferro chromium. Of this list, nickel is the most critical metal.

Mr. Overmyer, in commenting on the potential usefulness of his company's facilities for defense work, emphasized that his employees—those in the mold factories—are trained to work on cast iron or alloyed irons and his machine tools are designed to do certain operations on molds and mold parts. Hence, it would be quite a task to convert them to direct defense work. Following this thought, Mr. Overmyer stated that experience in the last war from 1941 to 1945 has convinced him that the economy would be better served by sticking to that which they know best. However, he stated if the government asks them to do any other job, they are ready to cooperate fully.

"Chet" told his audience in closing that while Overmyer Mould Company has been manufacturing molds a mere thirty-one years, 1951 marks fifty years that he has been a mold maker.

On the social side of the meeting, Maryland Glass Corporation's cocktail party, with J. Stanley Heuisler and Mr. and Mrs. Philip Heuisler as hosts, was a great success, held in the Old White Patio under delightful weather conditions.

The G.C.M.I. banquet was enjoyed by all and good weather brought out a full quota of golfers to vie for an attractive number of prizes.

Miami, Florida, has been selected for the Annual Meeting to be held November 28, 29, and 30, with headquarters at The Sea Isle.

• Harbison-Walker Refractories Company will build a new $3,500,000 silica plant at Downington, Pa.

IN THE MAKING OF FINE CHINA

Photograph Courtesy of Lenox, Inc.

• Continuous Glass Annealing Lehrs for every kind of glass • Continuous Convexing and Bending Furnaces • Continuous Decorating and Reannealing Lehrs • Continuous Conveyor Type Pottery Decorating Kilns • Special Processing Furnaces • Mould Heating Ovens • Recuperative Glass Melting Tanks • Consulting Engineering Service on All Heating Operations.

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BOOK REVIEWS

Silicate Melt Equilibria

By Wilhelm Eitel

Although the book is short, compact, and clearly written, it is difficult to review for the reason that nothing just like it has been published before. One might say that the book bears the same relationship to the chemistry of silicates as a book on blueprint reading bears to the subject of mechanical engineering; except that such a comparison would not do justice to the scholarly subject matter.

At any rate, the book sets forth all of the types of equilibrium diagrams likely to be encountered in silicate melts with proper explanations of the accepted conventions. Not the diagrams for any particular combination of oxides or silicates, however, but for components A, B, C, and D when they melt congruently, when they melt incongruently, when they form what the authors prefer to call crystalline solutions, and for every other phase relationship that is found in nature or in the laboratory. Particular systems that illustrate unusually well the various types of equilibria are mentioned as examples, but the actual data are left to the technical literature and to such compilations as "Phase Diagrams for Ceramists" by Hall and Insley (American Ceramic Society, 1947).

Whether a person has been using equilibrium diagrams a great deal or referring to them only occasionally, Eitel's book will be a useful tool to a better understanding. No attempt has been made to write an "easy" book, because silicate melts are not simple. Instead, the reader's time and mental effort is conserved by a logical and orderly development, by a simplified terminology, by an abundance of excellent drawings, and by the exclusion of all situations not likely to occur in silicates.

Although the book first appeared in German under tragic circumstances, the present volume is much more than a translation. It is really a new edition in English prepared by J. G. Phillips and the late T. G. Madgwick of the Department of Mines and Resources of Canada, a committee of distinguished American ceramists headed by R. B. Sosman and by Dr. Eitel, himself, from his present headquarters in the United States.

Published by Rutgers University Press, New Brunswick, N. J., 1951, 159 pages, $5.00.

R. F. FERGUSON

Tafelglas (Sheet Glass)

By H. Jebsen-Marwedel

An interesting monograph on sheet glass has been prepared by Dr. Hans Jebsen-Marwedel. The author is Technical Director of the Deutschen Libbey-Owens Company, but is perhaps better known in this country as the author of *"Glastechnische Fabrikationsfehler"* (Manufacturing Defects in Glass) published in 1936 and now almost a collector's item. Sheet glass is defined by the author as glass made by drawing continuous sheets or by flattening blown cylinders, whether used for windows or for some other purpose. Flat glass made by casting is not included.

The book is intended to fill the needs of anyone work-

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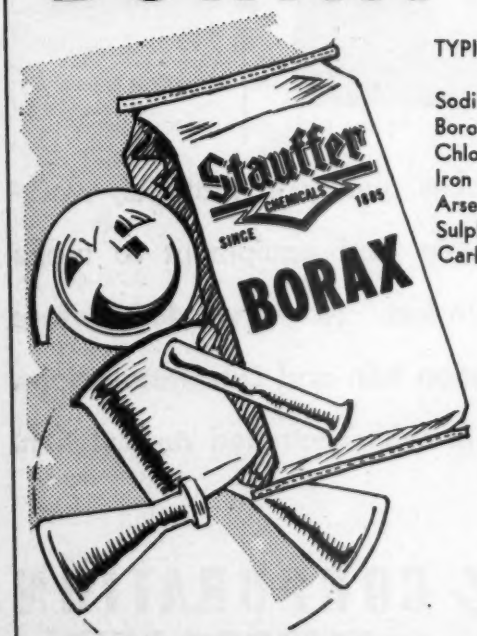

TYPICAL ANALYSIS	ANHYDROUS	TECHNICAL ($Na_2B_4O_7 10H_2O$)
Sodium Borate ($Na_2B_4O_7$)	99.25 to 99.50%	52.85 to 54.32%
Boron as B_2O_3	68.00 to 68.89%	36.75 to 37.74%
Chlorides as NaCl	0.10 to 0.16%	0.04 to 0.08%
Iron as Fe	30 to 35 Ppm	2 to 8 Ppm
Arsenic as As_2O_3	20 to 40 Ppm	3 to 8 Ppm
Sulphates as Na_2SO_4	0.3 to 0.4%	nil
Carbonates as Na_2CO_3	nil	nil

•

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ing with sheet glass who must know more about his material. Such readers would include architects, dealers, glazers, and fabricators. An introduction on how flat glass is made is given in non-technical language. Following in more detail are topics on sorting, cutting, and handling. The trade practices described are those prevailing in Western Europe and will not be applicable to the U. S. except, perhaps, to cause us to envy those countries that have adopted the metric system.

The second section covers properties of sheet glass. These properties include chemical durability, mechanical strength, and the transmission of radiant energy, both visible and invisible. These properties are carefully described with the user's interests always in mind. The third section of the book is devoted to those whose business uses sheet glass as its basic raw material. Details are given on such subjects as bending, etching, creating decorative effects, and the making of photographic plates and microscope slides.

A brief catalog of chapter headings such as the above does not do justice to the book. Such interesting details as how to hold a cutting diamond, how to make finger grooves in show cases, the light loss from different styles of window sash, how to test multiple layer safety glass, the proper way to store and open packing cases, and many others must be omitted from a short review. One feels all through the book that he is listening to an authority who can afford to be succinct. Here we have the work of a competent scientist with a wealth of experience who has taken the trouble to write for the users of his product. This authoritative knowledge, aided by 417 excellent photographs and drawings, explains why such a complete covering of so many subjects can be gotten into one book.

The language is not difficult, and anyone with even a fair reading knowledge of non-technical German should be able to understand most of the context. In this respect, "Tafelglas" differs from the author's previous book with the involved name and the untranslatable German. Anyone who is in any way interested in sheet glass and who can handle the language should find much of value in the current book.

Published by W. Girardet, Essen, 1950, 336 pages.

R. F. FERGUSON

K. C. MATTSON JOINS PENNSALT

Kirk C. Mattson has joined Pennsylvania Salt Manufacturing Company of Washington as District Sales Manager of the company's Los Angeles office.

Mr. Mattson will supervise sales and service of the Industrial Chemicals and Agricultural Chemicals Departments in Southern California, Arizona, Nevada, and New Mexico.

Mr. Mattson assumes his new position after 15 years' experience in the marketing of industrial and agricultural chemicals in California. Until recently he operated his own chemical sales agency, the Mattson Chemical Company, in Los Angeles.

• Paul M. Bigley, Assistant General Sales Manager, Michigan Alkali Division of Wyandotte Chemicals Corporation, has been appointed to serve with the E.C.A.

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REMMEY CRYSTALITE (mullite-bonded mullite) is produced in all shapes necessary to make up the forehearth assembly. Burner blocks, cover blocks, channels, spouts, tubes, plungers and orifice rings are built to meet specified requirements. These CRYSTALITE parts mean better, more efficient production by offering:

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CORNING GLASS CENTER . . .

(*Continued from page* 289)

in the artistic, historic, philosophic, and human relations aspects. To accomplish this goal, the Glass Center incorporates a new Steuben glass factory where galleries and balconies have been provided so that the public, for the first time, can view the blowing and forming of Steuben ware.

In the lobby of the Corning Museum of Glass at the Glass Center, two extremes of glassmaking, ancient and modern, are spotlighted where the craftsmanship of both the 15th century B.C. and the 20th century A.D. are on display. The Museum demonstrates every significant use that man has made of glass and discloses, in working reference collections, every basic technique, skill, and formula ever used in glassmaking.

Glass on view ranges from the earliest pieces—goblets of fine Venetian ware, millefiore and mosaic work, jewelry, overlay and decorative cutting, candlesticks, decanters—through to the most modern handling of glass. The glass displayed is representative of countless nations, eras of design, techniques, and execution, and artisans who have contributed to the development of glassmaking. An exhibit is devoted to Glass for Construction and covers a multitude of uses, including window glass, plate glass, glass blocks, foamglas insulation, and glass piping. Exhibitions of Glass for Illumination, Glass in Industry, Glass of the Future, and, finally, an exhibit which demonstrates the processes of glassmaking bring together one of the most complete exhibitions of its kind.

The Library of the Museum of Glass contains printed reference material in many languages which has been brought together. The library collection already exceeds, in quantity and diversity, the printed reference material on glass in such leading institutions as the Library of Congress, the British Museum, and the Bibliotheque Nationale.

The Glass Center represents a central place where all reference material on glass is available from which general premises can be drawn, and with its three-fold expansion of research facilities, its reference library, and in its actual producing plant, it should provide immediate service to the entire glass industry, as well as serving mankind generally.

SYLVANIA ELECTRIC APPOINTMENTS

Two new appointments intended to coordinate sales, service, and engineering in the Radio and Television Tube Division of Sylvania Electric Products, Inc. and to meet changing demands necessitated by mobilization have been announced by George R. Sommers, General Sales Manager.

D. W. Gunn has been named Equipment Sales Manager and G. V. Bureau has become Government Sales Manager. Mr. Gunn and Mr. Bureau report to H. P. Gilpin, Assistant General Sales Manager, whose duties have been expanded to include coordination of government tube requirements.

DURABILITY

BORAX...the proper substitution of B_2O_3 for a part of the alkali in the batch will improve the chemical and thermal resistance of the finished ware.

Our representatives are prepared to discuss all the special advantages of B_2O_3 in glass.

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METRO ACQUIRES DUNCAN & MILLER FACILITIES

The Metro Glass Bottle Company, through its wholly owned subsidiary Washington Glass Company, has announced the acquisition of the land and buildings of the former "Chartiers" plant of the Duncan & Miller Glass Company located in Washington, Pa.

Upon the completion of a modernization program, the plant will manufacture glass bottles. It is planned for production to commence by July 1, 1951.

• Robert Alexander has been appointed Cincinnati representative by McKee Glass Company. Mr. Alexander's headquarters will be at 7775 Stillwell Road, Cincinnati 37, Ohio.

• Milton M. Olander, Director of Industrial Relations of Owens-Illinois Glass Company, has been named as a management-member of the 18-man Wage Stabilization Board.

• Ralph O. Anderson, Norton Company district manager in St. Louis, Mo., has been appointed by the National Production Authority to serve in its Machinery Division as abrasive consultant.

• Guy H. Burrell, Executive Vice President of the Burrell Corporation, has announced the removal of the firm's offices and laboratories to new quarters at 2223 Fifth Avenue, Pittsburgh 19, Pa.

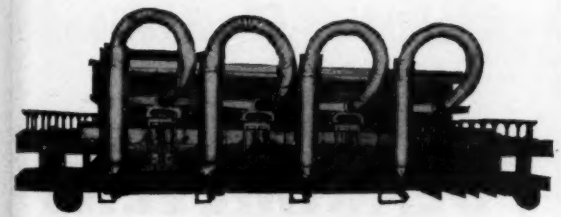
F. K. ZIMMERMAN ELECTED NEW PRESIDENT OF LYNCH

Upon the resignation of M. H. Pendergast as President of Lynch Corporation, the Board of Directors has announced the election of F. K. Zimmerman to succeed him. Mr. Zimmerman was formerly connected with PAR Refrigeration and Air Compressor manufacturing at Defiance, Ohio, before taking over the position as Secretary-Treasurer of Lynch.

Mr. Pendergast joined Lynch in 1938 when they purchased Modern Equipment Corporation, which he was then operating in the capacity of Vice President and General Manager. He was elected to the Lynch Board of Directors in 1941, served as Executive Vice President and General Manager until 1949 when he moved up to the Presidency.

• Dr. Alexander Silverman, Head of the Department of Chemistry of the University of Pittsburgh, addressed the Western Maryland Section of the American Chemical Society on "The Newer Glass".

FIRE POLISH WITH OIL



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Write for Bulletin 40E

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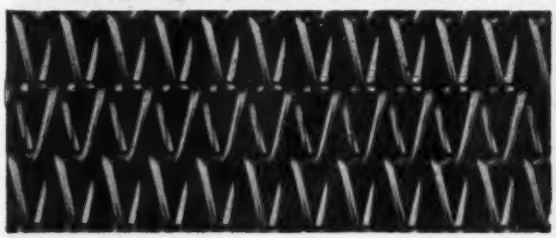

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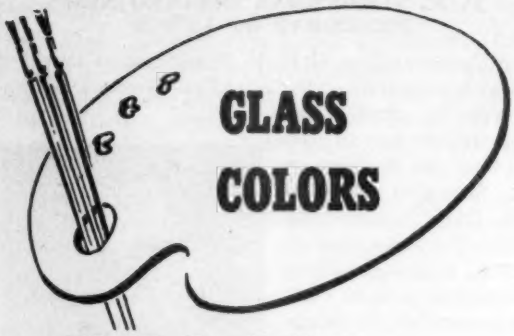

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INVENTIONS AND INVENTORS . . .

(*Continued from page* 302)

face of the opening while rotating the bearing at a high speed, 40,000 to 100,000 R.P.M. The size of the opening is determined by timing. Any excess material is then ground off the other side of the bushing.

The patent contains four method claims and the following nine references were cited: 493,808, Bechtold, Mar. 21, 1893; 742,345, Mygatt, Oct. 27, 1903; 756,935, Burrows, Apr. 12, 1904; 966,784, Anderson, Aug. 9, 1910; 1,721,983, Bailey, July 23, 1929; 1,993,774, De Bats, Mar. 12, 1935; 2,085,751, Holtz, July 6, 1937; 2,285,181, Wines, June 2, 1942; and 2,368,170, Smith, Jan. 30, 1945.

BALL BROTHERS NAMES MANAGER OF GLASS MANUFACTURING

Robert W. Biggs has been chosen to fill the newly-created position of Manager of Glass Manufacturing for four of the Ball Brothers Company's glass plants, according to a recent announcement.

Mr. Biggs, one of the country's leading manufacturing men, resigned a position as Operation Manager for the National Electric Products Company to join the Ball firm. In his new position, he assumes responsibilities for all phases of glass container manufacturing in two Muncie factories, one at Hillsboro, and one in Okmulgee, with complete authority for operating those plants and for managing all services related to glass manufacturing.

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BOOK ON ENGINEERING RESEARCH NOW AVAILABLE

More than 5,200 engineering research projects, representing annual expenditures of over $50.5 million, are now active in the engineering schools of American colleges and universities. These figures highlight the 1951 edition of the "Review of Current Research", published this week by the Engineering College Research Council of the American Society for Engineering Education.

The new book, which outlines the policies and activities of engineering research in the 91 colleges and universities holding membership in E.C.R.C., is the only complete guide to the current research contributions of engineering schools, according to Dr. Gerald A. Rosselot, chairman of the Research Council and director of the State Engineering Experiment Station at the Georgia Institute of Technology.

In addition to complete research project titles, the volume shows for each school the names of responsible administrative officers, a brief digest of policies which govern research projects and contracts at each institution, the number of personnel engaged in research activities, the annual expenditures, and special conferences and short courses of interest to research workers.

• The Hays Corporation has announced the appointment of Jack J. Tipton to the position of Chief Project Engineer. Until his present appointment, Mr. Tipton was Project Engineer primarily concerned with combustion control.

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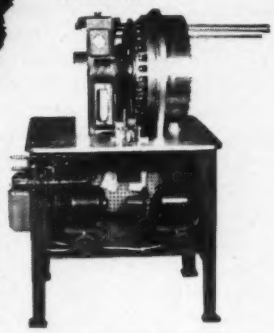

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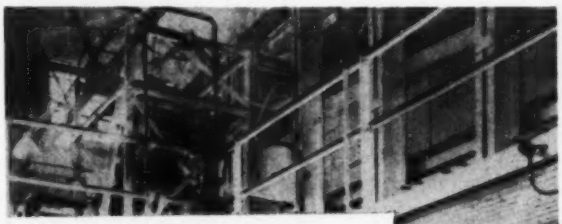

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